POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

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Operator at the Intake Control of Power Plant Air Compressor, Buick Motor Company, Flint, Mich. Photo, Ewing Galloway.

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Foreign delegates and distinguished American members of the World Power Conference assembled on the stage at the opening session.

"WE HAVE a strong conviction that any success that we may have in organizing the household of this nation now come of age, will depend in large measure on the degree to which and the manner in which we make available the natural energies which have been given us in great abundance. . . . . .

". . . . . Sheer inertia has caused us to neglect formulating a public policy for people to take advantage of the flexibility of electrical energy; that would send it out wherever and whenever wanted at lowest possible cost. . . . . What is economically sound is to be determined by social accounting more than by present methods."

———PRESIDENT ROOSEVELT
addressing the World Power Conference.

"FOR MY PART, I am convinced that if any great change is to take place in the American philosophy of power development, a change which looks toward a definite national policy, it will have to be by constitutional amendment.

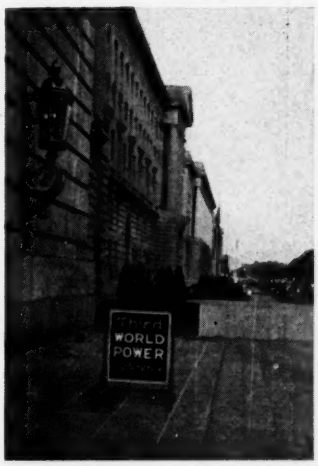
"The fact that work is now under way on certain projects carries no warranty that such projects are not infringements on the rights of the State and the freedom of citizens until they have been tested in the highest courts."

"In so far as I can speak for the industry, there is nothing that it will not do to further any plan formulated on sound economics for the public good."

———FLOYD M. CARLISLE,
Chairman of the Boards of the Consolidated Co. and the Niagara and Hudson Power Co. in discussion at the World Power Conference.

WITH THE EDITORS

The World Power Conference



FOR the Greater Good of Humanity, and the Advancement of Civilization, might well be taken as the permanent theme of the World Power Conference. That this consideration is but incidental to the primary, and often selfish, purpose of individual factions need not detract from the national and international benefits of such a gathering.

National defense, conservation, the desires of government agencies, personal aggrandizement, changing trends of public opinion, materialistic gains, industrial and geographic demands are but the threads which form the pattern of national life, and so long as these varied interests can meet on common ground, little real concern need be felt regarding the future.

Differences of opinion exist, yet certain general and international trends are evident, not from any particular paper or group of papers, but from the spirit of the conference as a whole. Duplication of facilities is universally frowned upon and monopolistic operation under a franchise in a given territory favored. Coördination demanded by conservation is not debatable, but the method of accomplishing this coördination is.

It is generally agreed that private industry must not be eliminated. It must be allowed to earn a fair return and be protected against individual and state encroachment. The majority, even France and Germany, are adverse to nationalization of power and fuels and such efforts started in several states have been abandoned. The function of government is to supervise and regulate, not own.

This country lags behind Europe in planning and there seems to be a strong and insistent minority faction trying to bring us in step without a thorough study of the factors which influence foreign trends, without a full appreciation of differences created by the immense territory covered and of past business traditions, and without allowing time for readjustment. Such changes can be accomplished quickly but at tremendous cost to the nation.

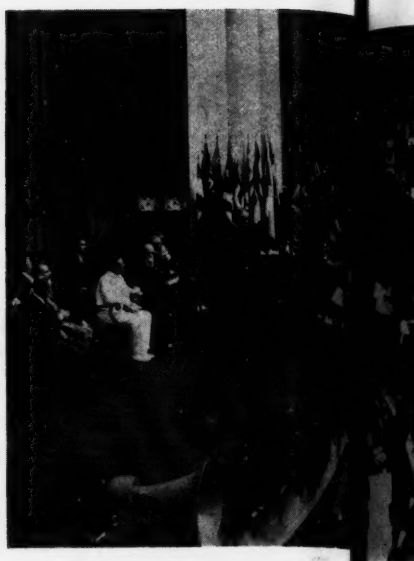
Most of the real difference of opinion comes in connection with power. Developments in other countries show that private companies have a definite place in any plan and should be encouraged, not discouraged, to develop power wherever it can be done economically. This does not mean that state development, and by state is meant national not municipal development, should be abandoned. Many potential power sites cannot be developed economically for power alone but are justified and necessary in connection with water supply, irrigation, flood control or conservation projects, with power generation incidental.

No private company could be expected to develop these sites and the utility industry raises no objection to state participation of this kind, provided there is a definite national policy assuring it that such work is not undertaken as a stepping stone to nationalization of power and other industries.

It is inconceivable that the severe criticism of past financial abuses of the utility industry be made an entering wedge to a serious attempt at nationalization of an industry that has played such an important part in and deserves much credit for the industrial development of the nation. That there is a concerted effort on the part of individuals connected with, and sometimes uncomfortably high in present administration circles, to do this cannot be denied. Whether the repeated warnings against such a step, voiced by foreign delegates to the conference, will bear fruit remains to be seen. A clear-cut statement by the Administration as to the planning proposed under present constitutional limitations or under suggested legislation would do much to ease the present well-grounded fears of the utility industry and enable it to proceed with needed construction and coöperate to the fullest extent with long-term national resource planning. Power is a major need and concern of the nation but a minor part of a complete conservation program. With the agricultural potentialities of our nation destroyed by floods, drought and abuses of agriculture, the need for power will disappear.

Two matters of import to the nation sprang from the Conference. First, it was demonstrated beyond a doubt that the two parties to our present crisis can meet and discuss their problems publicly without the injection of politics and personalities. The programs, meetings and arrangements were above reproach in this regard and but two or three incidents of individual bad taste, and beyond the control of the committee, occurred during the week. Second, a permanent agency for international coöperation on problems of power and its regulation was advocated by a Belgian government delegate. The proposal called for the appointment of an impartial representative from each nation at the Conference, he to select ten representative experts to form a permanent committee. Such a committee offers unlimited possibilities in stabilization of national policies.

RICHARD H. MORRIS.



President Roosevelt delivering his address just before he pressed the golden key that formally started the Boulder Dam turbines.

The Third World Power Conference

AT THE Third World Power Conference and Second Congress on Large Dams, which took place in Washington, D. C., September 6 to 12, volumes of data dealing directly with the economic and social phases of the power industry were presented to audiences totaling some 2000 engineers, scientists, industrialists and representatives of governments from 52 nations located in all parts of the world. From the formal opening on Monday evening to the impressive closing of the switch that started the generation of power at Boulder Dam by President Roosevelt on Friday afternoon, the Conference was filled with discussions of intricate problems recognized to be of serious moment.

The two previous conferences placed their greatest emphasis on the engineering technology of power generation. At this conference, however, the industry's financial structure and economic aspects, together with its relations to governments of various nations occupied the entire thought of the conference, leaving the technical part of the program to the Congress on Large Dams, which was held simultaneously with the Conference.

As might have been expected, many conflicting opinions were expressed on such controversial questions as private and public ownership of power enterprises, regulation and control of utility industries, financial practices of corporations, rate regulation and government subsidies. Partisan politics were barred from the discussions and only once during the entire conference was this rule broken. That incident proved so distasteful to the audience that further infringement of the rule was not attempted.

To get a picture of the conception of the program, the conduct of the meetings and the choice of speakers as well as the arrangement of the preconference and post conference tours which were participated in principally by visitors from foreign countries, it is quite essential to keep in mind the officers of this Third World Power Conference, the members of the American National Committee and the make-up of the Executive Committee. First of all it should be stated that the actual work of the Conference started when the government appropriated $75,000 for this purpose. To this was added $75,000 donated by the utilities, and $25,000 by manufacturers some months after plans had begun to be formulated.

Conference Organization

Honorary president was Franklin D. Roosevelt, President of the United States; honorary vice president was Harold L. Ickes, Secretary of the Interior; chairman, William F. Durand, consulting engineer; and director, O. C. Merrill, consulting engineer. The officers of the American National Committee were: chairman, Harold L. Ickes; vice chairman, William F. Durand; chairman of executive committee, Morris L Cooke, administrator, Rural Electrification Administration; and executive secretary, Joel David Wolfsohn, Executive Secretary, National Power Policy Committee. The Executive Committee consisted of nineteen members, eight of whom hold federal or state govern-

and The Second Congress on Large Dams

ment positions, six may be classed as private utility executives, two are executives of manufacturing concerns and one executive of a state university, the remaining two are on the staff of the Conference. Additional members who worked on the committee were sixty-six in number, thirty of whom were connected with the federal or state government, eleven representing independent interests, ten utility executives, three labor organizations and two manufacturers.

The major interests of the majority of the working committee were clearly reflected in the subjects chosen for discussion at the Conference. Further recognition of the part played by the government in conducting the meeting may be gained from the knowledge that representatives from the various states were appointed by the governors of the states. The suggestion made by the management was that appropriate appointments might be evenly divided between college professors and utility executives.

Although engineers were not lacking in number in the audience, they contributed little to the discussions carried on at the meetings of the Conference, undoubtedly because the topics under discussion had to do with governmental and company policies which are essentially problems which must be solved by executives.

The Conference as a whole might readily be characterized as a meeting of the power minded executives and government officials of the world, called to the United States to present facts on the power industry in their countries which might be used to guide government officials of all nations in formulating policies which would work to the best advantage of the people as a whole. There was warning aplenty from foreign representatives against too rapid changes in governmental policies and many in the audiences gained the opinion that the most successful power policies of European countries, as well as some in South America, are not in the least antagonistic to private ownership and operation. A degree of control, however, exists in all countries, but this is not confiscatory in its operation.

One of the most valuable results of the Conference is the fact that it places in the hands of all interested people real facts from which helpful opinions can be drawn and it is to be hoped that public speakers on power questions will be guided by the facts brought out at this Conference and, in their efforts to mould public opinion, will advocate those policies which have proved to be the most successful from both economic and social view points. This may truly be termed an engineering type of approach.

Discussions in Four Languages

Lack of ability to speak more than one of the four leading languages seemed no handicap to people in the audiences as the public address systems in the various auditoriums worked perfectly. At each seat was a set of head phones attached to a switch permitting the listener to tune in on his preferred language as the speaker's words were being translated by interpreters in an adjoining room. All papers and discussions were recorded by dictating machines so that the final records of the Conference will be accurate and complete.

Temperatures in Washington during the entire week were unusually high, so was the relative humidity but

these conditions were little handicap to the meetings as two of the auditoriums were air conditioned. The meeting places were the Government Auditorium in the Department of Labor Building, the Commerce Auditorium in the Department of Commerce Building, the National Museum Auditorium and Constitution Hall. The attendance at sessions, which were of two hour duration, ranged from 100 to 500 at regular meetings with Constitution Hall crowded to capacity at the special meeting addressed by President Roosevelt.

Opening Meeting

Important indeed is the opening session of any convention, extremely so in a conference of world wide import. Monday evening in Constitution Hall an extremely impressive program was staged to prepare the minds of the assembled power authorities for the serious consideration of the topics to be discussed at the meetings to be held within the week. There was the orchestra with appropriate music. The stage was filled with delegates from fifty-two nations all in extreme formal attire, all wearing their decorations of honor. The stage was flanked with groups of the flags of the nations represented. The principal addresses were given in the English language but responses by representatives from various countries were given in the language of the country.

Dr. Julius Dorpmuller, President of the World Power Conference, in a brief statement declared the Third World Power Conference open. M. Mercier, Chairman of the International Commission on Large Dams, declared the Second Congress on Large Dams open. Dr. Durand then assumed his position as chairman of the Conference and in four languages welcomed the participants in both the Conference and the Congress.

The chairman then introduced Secretary of State, Cordell Hull, who welcomed the participants in the name of the Government of the United States. As joint hosts with the United States, the Chairman introduced from Canada, Dr. Charles Camsell, Deputy Minister of Mines and Chairman of the Canadian National Committee; from Argentine Republic, Rodolfo E. Ballester, Faculty of Exact and Natural Sciences of the University of Buenos Aires; from Mexico; Jose Colmo, Assistant Chief, Petroleum Bureau, Minister of Industry and Commerce, each giving a word of greeting to participants from across the seas.

Responses to these addresses of welcome came from Germany, Director Carl Krecke, Leiter der Reichsgruppe Energiewirtschaft, and Chairman, German National Committee; from Poland, S. J. Zowski - Zwierzchowski, Professor of Hydromechanical Engineering, Polytechnic School of Warsaw; from Belgium, L. van Wetter, Director General of Waterways, Minister of Public Works; from Denmark, H. H. Blache, Burmeister & Wain, Ltd., and Chairman, Danish National Committee; from Lithuania, Jurgis Ciunlys, General Manager, Lithuanian State Railways, and Chairman Lithuanian National Power Committee; and from Italy, Professor Giancarlo Villauri, Vice-President, Royal Academy of Italy, and Chairman Italian Delegation.

One paragraph from the address of Dr. Durand expresses the purposes of the Conference so concisely that it is quoted here:

"It thus becomes our duty, as guardians of a trust, to examine the present and to look into the future; to take such stock as we may of our available resources, to study the most efficient modes of energy liberation and transformation into power, and the most serviceable and useful modes of distribution and delivery at the points where its services are required. In order to give special direction to our deliberations on the present occasion, it has seemed wise to pay particular attention to the extent and character of our resources, to problems of wise exploitation and forward looking conservation, to those factors which relate especially to the distribution and delivery of power to the ultimate consumer, and generally to the methods and forms of organization and control best adapted to realize the maximum of useful service at the minimum of cost to the largest number of people."

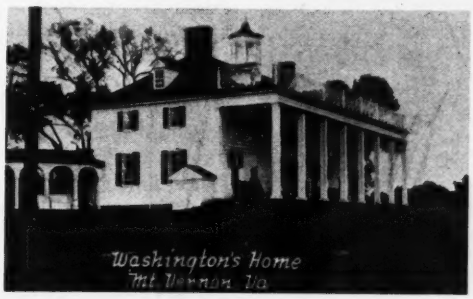
The next event in the pageantry of social events of the Conference was the reception and dance on Tuesday evening. It was formal, of course, and the start of many luncheon and party engagements lasting through the Conference.

Informal and extremely enjoyable after a hot day in the busy city was the garden party given by the American National Committee at the Robert Woods Bliss Estate. The enchanting nooks, fountains, flower gardens, orchards, winding pathways, velvety lawns occupying a half hundred acres on the banks of Rock Creek were the envy and admiration of everybody, particularly the Japanese whose artistic tastes for horticultural beauty have gained the praise of the world.

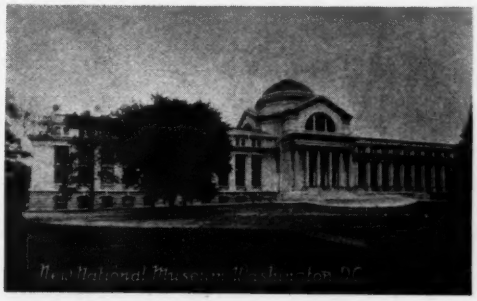
Dinner Served in Depot

Washington accommodations in regularly constituted banquet halls failed to provide sufficient capacity to serve the great number expected to attend the dinner given in honor of the delegates and members of the Third World Power Conference so by special arrangement the Hall of Transportation in the Union Station was turned into a magnificent banquet hall where 1570 were served a full seven course dinner by a staff of experts imported from New York. This hall has stood out for years as a masterpiece of architecture and lighting but this is the first time it has served as a banquet hall.

Extreme formalities were the order of the evening, the flags of all nations draped the architecture of the walls; each speaker was announced with the sound of a trumpet and stood between flag bearers carrying the United States flag and the flag of his own country; the moderately spoken words of the speakers were amplified by the public address system to a volume that was comfortable for every listener in the hall. With Dr. Durand presiding, many toasts were drunk and addresses were delivered by Dr. Frank D. Lillie, Secretary of the Interior Harold L. Ickes, Senator Leon Perrier of France, Dr. H. J. van der Bijl of South Africa, Senor Don Enrique Gongora of Peru, Floyd L. Carlisle, The Right Honorable Viscount Falmouth of Great Britain, Ing. Rudolf Fuhrman of Austria, Direktor W. Borgquist of Sweden, Owen D. Young, Dr. Masawo Kamo of Japan, Dr. J. Büchi of Switzerland and Eng. Miguel Villa y Rivera of Cuba.



Outstanding among these addresses were bits of philosophy spoken by Mr. Carlisle, such as "As the world grows in complexity we grow in knowledge and experience further to direct and to perfect these mechanisms..... Literally the development of the tool and of trade has marked man's successive steps upward from the level of the beast..... As there are constant and unchanging moral laws, so also there are unvarying economic laws..... Business and government have no natural or inherent antagonisms . . . . I commend to the Government and to the industry the application of Aristotle's Golden Mean."



Impressive was the intense interest evinced by the audience in Constitution Auditorium on Friday afternoon when President Roosevelt, after delivering an address in which he advocated certain power policies, reached to the pedestal beside him and with his finger on the button released forces that opened needle valves at Boulder Dam and commanded: "Boulder Dam, in the name of the people of the United States, to whom you are a symbol of greater things in the future, in the honored presence of guests from many nations, I call you to life."

Immediately the answer came by radio from Boulder Dam, a voice described the scene as the water began its discharge from the tunnels and the purr of the water-wheel generator was distinctly heard in this far away auditorium.

Power on Parade

To those not interested in attending all the meetings of the Conference and the Congress, ample diversion was provided by the committee in arranging special exhibits dealing with power subjects. These were located in the Hotel Mayflower, the National Museum, the Bureau of Standards, Carnegie Institute, Chesapeake and Potomac Telephone Co., Geological Survey, Library of Congress, National Academy of Sciences, Smithsonian Institute, Potomac Electric Power Co., Rosedale Electrified Farm, U. S. Patent Office and the Washington Gas Light Co.

Of great interest was the public showing of Dr. Charles G. Abbot's solar heat engine, a device made up of cylindric concave mirror surfaces that focus the rays in a glass tube where they are absorbed by a black liquid called Aroclor. The heated liquid, expanding, rises to a reservoir above, and a return tube

President Roosevelt pressing the golden key which started the water through the first turbine at Boulder Dam

under the mirror completes the circulation. The heated Aroclor passes through a heat exchanger that generates steam at pressures as high as 175 lb. Failure of the device to operate at the time of the delegates' visit was explained as due to the melting of a soldered connection in the Aroclor circuit an hour or two before the demonstration was planned to take place.

No visit to Washington either by Americans or by people from foreign lands would be complete without taking time to pay tribute to the Father of our Country, by giving thought to the many blessings that have come as a result of his guidance during the birth period of our government. Such meditation can best be done in the home he occupied at Mount Vernon and while strolling over grounds he planned and cultivated. For the trip from Washington a large boat was chartered and its capacity was taxed to accommodate the visitors.

As a fitting close to the Conference, Dr. Durand was chosen to be President of the World Power Conference and his final address included the following paragraphs which put into words the thoughts of many who attended the conference:

"The importance of such meetings cannot be overestimated. They are fundamental as a condition for the wise and effective treatment of these great problems, the study and the treatment of which must be approached and applied from a world viewpoint, rather than that of any one section or country.

"We who approach our problems in the true scientific spirit have, in this, a common mode of thought, the mode of thought characteristic of science, engineering and technology. We have thus, in a sense, a common language, regardless of the particular tongue in which it may be clothed. We are able thus, to sit down together and study, with a common purpose our problems, exchange information regarding our methods and practices, and thus move forward together toward wise and effective world solutions of these matters which we have chosen as our part in the world's work.

"May we not even venture to hope that diplomats and statesmen may find, in our mode of approach to the problems with which we deal and in the attitude of mind and heart with which we approach these problems, something by way of an example for the approach to the problems with which they must deal, and which are so vital in the search toward better world understandings."

"In a word, may we not hope, by the continued study of our own problems in our own way, to form, in conjunction with other like scientific and technical international organizations, a strong nucleus of better world understandings and to set an example of the way in which we may hope successfully to reach the goal of a durable world peace. Insofar as we may contribute to this end, so shall we the more effectively fulfil our whole duty, not only in our own chosen field of engineering and technology, but as a factor in the solution of those wider problems which deal with the continuity and the security at the present phase of human civilization."

So much for the general picture of the Conference In articles which follow a more detailed consideration is given of the papers presented and the discussions which took place.

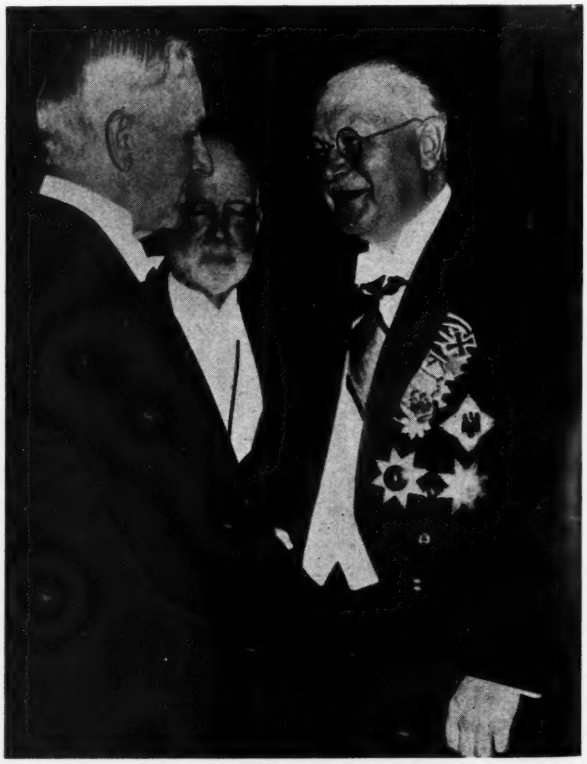


Fig. 2. World Figures exchange greetings. Left to right: Secretary of State Cordell Hull who welcomed the 3000 delegates; Dr. W. F. Durand, chairman of the Conference, and Dr. Julius Dorpmuller of Germany, President of the Conference

World Power Conference

Section I

BASIC TRENDS

Physical and Statistical Basis of the National Power Economy: Technical, Economic and Social Trends

PAPERS PREPARED on the general topic of the national power economy were grouped together and designated as Section I. Paper No. 1 in this section dealt with Power Resources, Development and Utilization and was concerned with the actual statistics of major facts relating to fuels and power. Its main purpose was to ascertain to what extent the statistical methods of various countries are such as to furnish a satisfactory basic for international comparison. That many countries failed to contribute to Paper No. 1 is fairly clear evidence that such statistics are not immediately available; only 15 of the 52 participating countries supplied data.

Information was submitted by the three largest coal-producing countries and by several other countries which produce considerable quantities of coal, but they are lacking for some half dozen important coal-producing countries.

The most important statistics relating to power are those of resources in fuels and water power, production of primary fuels and of hydroelectric current, and net consumption of fuels and power exclusive of duplications between primary and secondary. The principal natural resources are the deposits of coal, petroleum, and natural gas, and the power capacity of streams. The paper from Holland made reference to wind power and to the potentialities of tidal power, but these were not considered essential forms of power in the world as a whole.

It is recognized that estimates of the quantity or area of mineral deposits and the capacity of water-power sites are at best comparatively inaccurate. This suggests a field of research to devise methods which can be standardized for the use of all countries. Statistics on production of petroleum, coal, natural gas, and hydroelectric power were much more accurate and are kept in many countries, but evidently not universally. It is reported that the United States Census Bureau in 1929 attempted to collect statistics of the electric equipment of industrial concerns and the quantity of current generated, but the data proved too incomplete to warrant publication, although similar data on public-utility electric plants are available.

Use of Electric Current is Increasing

Nearly all countries report definite increases in the amount of electric current output since the low point reached in 1932. At present, most countries have reached or passed the previous peak reached in 1929. This upward trend is expected to continue without interruption due to the present and future plans to penetrate the rural areas, the development of devices not yet commercially used, lowered rates brought about by greater efficiency of production and the increased use of electricity—rather than steam—by industry and railroads. It is not expected that increased unemployment will result from this greater use of power, but that more fields of employment will be opened up to absorb all available operatives, clerical and technical workers. All this, it is thought, will be accompanied by a higher standard of living as has been noted in such countries as Poland.

Throughout the world, the trend is toward a more efficient use of coal in the production of power, and an increased use of gas and water power. This opinion is based on reports from Germany, Great Britain, Hungary, Austria and the United States. This high state of development of the industry is accounted for by the authors of many papers by the large freedom of private enterprise, the abundance and variety of resources and foreign and domestic demand. At the same time many opportunities for advancement are recognized by industrial leaders.

Significant Trends in the Development and Utilization of Power Resources

Under this title was presented Paper No. 2 in Section I, which was a compilation of papers on this subject submitted by ten countries. Although this paper

was concerned primarily with significant trends of a technical, economic, or social nature, it was evident from the papers that those trends reflect innumerable related activities both within and without each country.

Hungary recognizes as its first step the establishment of coöperation between plants as one means of preserving the supply of Hungarian coal. Progress in electrification is a significant trend in Poland where the number of electric plants has increased from 835 in 1925 to 2561 at present, most of which are of capacities below 100 kw. and located in sparsely populated provinces.

Electrification of railroads stands out as a recent development in Switzerland where 76 per cent of the railroads are now electrified as compared to 21 per cent in 1915. Water power is the principal source of power here and, in addition to the railroads, chemical industries and notably the homes, which are almost universally electrified, are users of large amounts of power.

Due to the loss of a large part of its coal fields during the World War, Austria embarked on a program for the development of its water-power resources. This program has brought about a shift from 97 per cent imported coal-generated power in the city of Vienna in 1913 to 73 per cent hydro and 23 per cent domestic coal-generated power. Imports of oil are steadily increasing in this country.

The increasing use of brown coal is noted as a significant trend in Germany. Interconnection of power plants through a high-tension grid system was pointed out as helpful to the industry.

In the United Kingdom, the primary source of power is from domestic coal sources with imported petroleum ranking second in importance. Production of coal, however, is declining, due in part to increased efficiency in coal-using equipment and the development of the grid system of electric distribution.

Trends of conditions in the United States are too well known to readers of Power Plant Engineering to require mention here. To achieve the highest social-economic value of power, it was indicated that the following steps are involved: Elimination of excess rigidity in the price structure, liquidation of inflated debt burdens, and higher real wages, based on other assumptions than that labor's input of physical energy represents a just measure of its share in the social income.

Collection, Compilation, and Publication of Statistics With Particular Reference to International Use

This, the third paper in Section I, was closely associated with Paper No. 1 and dealt considerably with the statistical agencies through which the industry secures information on fuel and power in national economic life. Private and public agencies are relied upon in many countries with the central government assuming responsibility for the most important data, much of the detail work being done by subdivisions of the country, such as states, depending to a large extent upon the co-operation of the industries. In some instances, governmental statistical organizations or bureaus are charged with this duty.

It is noted that in most countries reporting, compulsory returns may be required of the industry, while others rely upon voluntary supply of the needed information. The individual or concern voluntarily furnishing the data must be assured that information supplied will be held confidential, if adequate returns are to be expected.

In different countries, the scope of fuel and power statistics varies widely, but most countries collect more than what is considered basic figures, namely, output, imports and exports. Some of the additional data are: consumption statistics, thermal capacity of coal, technical aspects in coal mining, labor in coal mines, prices of coal, and rates for gas and electric current.

Naturally the authors of papers were able to say little concerning the methods of analysis of fuel and power statistics in their respective countries. Adequate analysis adds greatly to the significance of economic statistics. For example, much can be learned from grouping production according to regions, size of producing concerns, the methods and equipment used, and the like, as well as from averages, percentages, and comparisons with previous periods. The special conditions of each country more or less preclude international standardization of methods of analysis but nevertheless each country may readily profit by studying carefully the methods used in other countries, especially those where conditions resemble its own in some measure. Very few countries now draw from their statistics all the significance of which they are capable. An expert staff in a central international office could render much service.

Fig. 10. High scalers at Boulder Dam. These are the men who performed the perilous work of stripping loose and projecting rocks from the walls of Black Canyon. (Photo, courtesy Bureau of Reclamation)

Organization of the FUEL INDUSTRIES

COAL PRODUCTION and distribution is a natural world-wide problem due to its wide spread distribution while oil, due to the localized nature of the major producing fields, is for most countries an artificial problem brought about largely by the ever increasing demand for motor fuel. Gas, on the other hand, while equally important, is a supplemental problem closely related to either the coal or oil industry depending upon the nature of each nation's major reserves.

Technically, all nations have shown great advances of recent years in production processes, mechanization in the United States having been particularly rapid so that now in bituminous coal mines 84.1 per cent of the cutting is done by machine. Coal consumption in this country is still 15 per cent below the 1929 figures, and, due primarily to oil and gas consumption, increased efficiency of industrial utilization and the fact that transportation costs often exceed the actual coal cost, it is extremely doubtful whether the consumption will increase materially during the next few years. This, combined with over development, places the American coal industry in an extremely critical position.

The coal industry looks to new uses and technical advances to bring coal into its own and eventually to supply the power now derived from other fuels. Others, however, feel that more immediate steps, namely, government regulation, are necessary. Ventures along this line have so far been experimental and two attempts, under the National Industrial Recovery Act and the Bituminous Coal Conservation Act of 1935, have been invalidated by the Supreme Court.

Further developments are mere conjecture but, if European trends and proration in the oil industry are any indication, some coal proration arrangement under state statutes to prevent waste will probably be the final outcome. With proration working in both the coal and oil industries, it would be but a short step toward the ultimate goal in view by the regulation and conservation forces, i. e., proration between industries by some central body.

Much the same general coal problem exists in England, and the trend toward control found expression in the Coal Mines Act of 1930. This aimed, among other things, at regulation of output in accordance with anticipated demand, proportioning the national production between districts and establishing minimum prices for each class of coal. The Act did not accomplish all that was expected, but is now in the process of being strengthened. In other countries, for instance Germany, France and Japan, the government exercises more direct and complete control either by participating directly in the business or by strict legislation.

Control of Oil Production

Practically non-existent oil reserves in Europe and the increasing demand for motor fuels have stimulated research in those countries along the line of carbonization and hydrogenation of coal. This phase has not been neglected in this country, but adequate petroleum reserves remove the necessity for immediate commercial needs. In England the British Hydrocarbon Oils Production Act provides financial assistance to certain of these industries and one plant so built is designed to produce, from coal and tars, 45 million imperial gallons of motor fuel annually, equal to about 4 per cent of the total consumption. On the continent, interest in this problem is also paramount, and includes in addition, an active interest in alcohol for this purpose. Sufficient success has been attained to indicate that coal and alcohol together might well replace petroleum products for this purpose if necessary, but, of course, at an advanced price.

As is the case with coal, the major European countries exercise close supervision of petroleum possibilities. The British Petroleum Act of 1934 vests ownership of oil properties in the Crown and grants licenses for prospecting. As owner of the mineral, the govern-

ment retains a certain measure of control and the act provides for voluntary or directed development of each tract as a unit. In Argentina, except for limited concessions, mineral rights belong to the state which operates a government agency for the production, refining and marketing of petroleum products in such a way as to stabilize prices. American oil production and conservation methods are mentioned briefly in a later article, the early development of the industry in this country under the rule of capture leading to many special problems.

Gas Systems

Practically exclusive use of manufactured and by-product gas in Europe has prevented the development of extensive gas lines, although a number of smaller grid systems have been developed in England, France and Germany. It is said that local conditions limit the economical transportation of this gas to distances of about 20 mi. in France and 30 mi. in England.

In Germany the industry is more highly organized and rapid progress is being made toward even more complete unification. More than half the gas of the nation is supplied from large networks connecting coke plants at the mines. Three hundred cities are already connected to the larger grids. Unification of the different supplies, by-product industries and elimination of less efficient plants are expected to accomplish much and it is hoped that even the correlation of the by-product supplies with power production will entirely eliminate waste.

World Power Conference
Section III

Organization and Regulation

IN THIS section, authors from various countries were requested to discuss the organization and operation of private and publicly-owned electric and gas utilities from the standpoint of their functions and obligations, dealing with such problems as: The consolidation of operating plants into interconnected operating systems and into systems beyond the limits of interconnected operation; the methods and agencies of consolidation employed; the problems arising from common ownership or control of private gas and electric utilities and of control by non-utility interests; the nature and extent of regulation exercised by the State through permanent commissions or otherwise; the form and extent of public ownership of gas and electric utilities; the conditions under which publicly-owned utilities are operated; and the position which public ownership and operation occupy in the entire field of gas and of electric-utility service.

Organization of Private Electric and Gas Utilities

Ten countries responded with data on this subject, tracing the history of these industries in their countries from the very beginnings. Gas utilities started about 125 yr. ago but the first electric utility was put into operation only 55 yr. ago.

Electric and gas utilities have developed in various ways dependent largely upon the form of government, tradition of the country and the economic status. In some countries, foreign capital has played a major part; in other nations, public ownership and operation has dominated these industries; in other lands, private control has been entirely or almost entirely responsible for their growth and development; while in still other countries, private companies, municipal plants, State or Province ventures, and mixed public and private schemes have each contributed to building and operating these industries.

In France, the first stages of consolidation consisted in the amalgamation of local companies into larger corporations. In the next stage, some of these corporations were acquired by a single interest. This, in general, seems to be typical of the development of the industry in many countries, although in more recent years many utility interests have been acquired by investment bankers and manufacturing interests. The development of long distance transmission of electric energy stimulated the consolidation of small private and publicly owned enterprises into large connected units which could avail themselves of the hydroelectric developments and also of larger, more efficient generating units.

In France, the State has never sought to finance the thermal production of electric energy but the law of 1919 recognized the principle of the participation of the State in the cost of harnessing water power. The pyramid holding company groups appear to be almost entirely found in the United States. In Great Britain power companies must obtain from Parliament

specific powers as to the amount and class of capital raised and their investments, but there is nothing to prevent their association as a subsidiary to a limited company constituted under the general law.

In none of the countries reporting was either the gas or the electric-utility industry controlled by a single company; in all, however, mergers and consolidation have taken place, particularly in the electric industry during the past decade.

Delegate Salazar of Equador declared that his country's problem is not the relative merits of public and private operation of utilities, but the obtaining of international capital to develop the water power resources of the country. The Belgium delegate, M. F. Horn, spoke in favor of the holding company mechanism as a means of obtaining the advantages of coördination. E. J. Fottrell of Great Britain sees no disadvantages in smaller companies being joined together through a holding company so long as the public interest is adequately protected by government. The grid system was cited as the major advance of importance in Great Britain by Viscount Falmouth who recommended that the American public regard the voice of experience and look to the future development of electric power with a minimum of government aid until standardization is more nearly reached

Public Regulation of Private Electric and Gas Utilities

Nearly every country submitting information on this subject recognizes the fact that electric and gas utilities are businesses carried on with a public interest and are therefore subject to a degree of regulation to which ordinary private business usually does not have to conform. It is noted, however, that the character and extent of regulation in practice vary widely in the different countries. The laws of most countries provide that public utility companies furnishing electric and gas service should enjoy a monopoly in their respective areas but in some countries there is provision for competition where it is deemed necessary to protect the public interest.

Probably the most distinctive feature of regulation generally is the frequent reliance entirely on concession agreements to protect the public interest, although there is a noticeable tendency in several countries to depart from this form of control in recent years by setting up control administrative authorities with more or less plenary regulatory powers. In some cases this centralized control does not supercede that exercised under the concession agreements but is intended to promote uniformity in the concessions to be granted and to establish an agency for administrating the control provided for in concession agreements.

Reasonableness of rates is a matter of primary concern in utility regulation. The responsibility for rates is handled in various ways in the different countries. In a number of instances, rate control is limited to stipulated maximum rates, set forth in concession agreements. In some countries, it is evident that there is relative inflexibility in the provisions relating to rate changes. The underlying principle of rate control is in most cases one which allows the utility company to earn a certain percentage rate of profit on the amount of money invested in the undertaking.

A timely warning which was appreciated by his hearers was given by John Dalton, Manager of the County of London's Electricity Supply in the following words: "If we want to develop our industry to the advantage of our customers and the millions of small investors in our stocks, let us for Heaven's sake keep the politicians away from this industry of ours to which we are all so proud to belong."

Strictly fair competition was expressed as the prevailing principle in European countries in the relationship between private and publicly owned enterprises and several representatives expressed opposition to the "yardstick" and "birch rod" methods of dealing with the rate problem.

Organization, Financing and Operation of Publicly-Owned Electric and Gas Utilities

To this topic thirteen countries contributed discussions. These were of a descriptive nature and have two characteristics in common: The emergence of national policies for control, through stringent regulation or government ownership or both, of the total electric power industry on the basis of the total public welfare; or the modification of traditional governmental structures and jurisdictions in adaptation to the evolving technological structure and administrative demands of the power industry.

Two further trends are significant: The dominant position now universally accorded to considerations of the public welfare in the development of electric services has modified the character of the traditional debate between advocates of public and private ownership so that both are today being appraised in terms of measurable technical and economic efficiency, that is as instrumentalities rather than as emotionalized symbols of divergent political philosophies. 2. The second of these tendencies is evidenced by the establishment of non-political power authorities, designed to safeguard the administration of power services from the instability not only of public political caprice but also of the speculative caprice of private business.

In Switzerland the Federal government has, by legislation, general supervision in this field, but complete freedom of economic activity is left to private initiative, cantons and municipalities. In the field of distribution publicly owned utilities outnumber the private concerns but in the large hydroelectric stations private ownership plays an important part. Close cooperation between the various groups is a result of wholesale supply by private utilities to the public owned systems and to the joint ownership and operation of many utilities.

The French state has never taken a direct part in electric energy generation plants but has facilitated construction of certain hydroelectric stations. Subsidies given were for the purpose of extending the national exploitation of the national hydraulic resources. Similar subsidies have been given to facilitate transmission lines and rural distribution system construction. Until recently private industry was allowed considerable liberty but excessive competition brought about an economic crisis and the state intervened to bring about coördination.

E. J. Fottrell of Great Britain considers that the main difference between private and publicly-owned enterprises in his country is in the rate structure; the rates charged, however, show but little difference.

World Power Conference
Section IV

Conservation of Fuel Resources

Some Nations are faced with early exhaustion of reserves but adequate supplies in this country allow time for intelligent planning

CONSERVATION of natural resources, recognized as vital in all civilized countries is a multiple problem involving national or regional planning, efficient and complete production and effective utilization. From an engineering standpoint the problem is capable of solution but unfortunately engineering is but a minor factor, being over-shadowed by legal and political difficulties growing out of established institutions, laws and habits.

With power as the backbone of our modern industrial civilization, water, coal, petroleum and natural gas emerge as the dominant resources to be considered. Of these, water power is, perhaps, most generally considered public or common property, and of recent years there has been a worldwide trend toward more direct government participation in that phase of power development. Since 1917, all sites acquired by private interests in Norway revert to public ownership in 50 to 60 yr. In Germany, prior to 1914 the mixed ownership company was common, generally one-half of the stock being held by private owners and half by the government.

In this country, excluding recent government bodies, regional development has been carried on by private interests, the Southern California Edison Co. and the Pacific Gas & Electric Co. being outstanding examples, from an engineering standpoint, of regional planning of water power with wide-spread interconnected systems and gas-burning plants to utilize both water and waste gas to best advantage.

Planning for power is, however, but one phase of the broader problem of national conservation or economic planning, which aims to obtain the highest per capita standard of living at the lowest man-hour cost without stoppage or violent fluctuations and with a minimum wastage of national resources.

This again may be divided into two major problems, one dealing with replaceable and the other with non-replaceable factors. Replaceable resources such as soil, water, forests and grass must be utilized only as they are replaced by Nature; non-replaceable minerals must be conserved, while new and abundant substitutes are developed faster than the old materials are used up. As Stuart Chase says, "Technology races with waste."

Technically, advances of recent years have been rapid, methods of recovery have been improved, a greater proportion of the total yield is utilized and the resulting product is used more efficiently. The problem that remains is the co-ordination of the conflicting needs of each to the needs of the nation as a whole.

As the newcomer in the field, with fewer traditions and habits, with great potentialities and limited power reserves, yet a serious threat to the old and established coal industry, it is perhaps natural that the petroleum industry be the first example of national planning. Under the term "proration," effective legally under various state statutes to prohibit waste, production is controlled approximately in accordance with consumption estimates by the Bureau of Mines. To be successful it has been stated that four requirements must be met: (1) The administration must be effective; (2) it must cover all important fields; (3) it must not lead to unnecessary prices; (4) it must prohibit non-economical wells.

Proration does not, of course, protect individual fields from wasteful production, but "unit operation," whereby a given field is worked as a unit, ensures each land owner his rightful share and ensures maximum production by maintaining desirable gas pressures and gas-oil ratios.

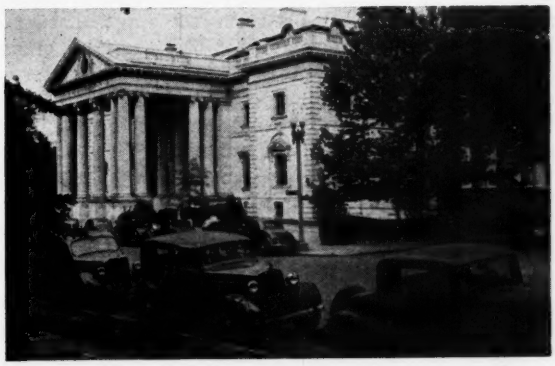
Whether the rapid development of the petroleum industry is sufficient justification for past waste seems open to debate, but there is no question but that tech-

Fig. 11. Dr. C. G. Abbot with his associates and the solar radiation boiler which they have constructed at the Smithsonian Institution. The 3 mirrors collect sun rays over 36 sq. ft. and focus them on 3 vacuum jacketed glass tubes containing high boiling black liquid which raises steam to 175 lb. pressure in a boiler at the rear, sufficient to drive a ½ hp. engine

nical advance in discovery, production and refining have added greatly to the available oil reserves. Research has pointed the way to make crude oil and gas yield higher percentages of desirable products than formerly by polymerization, hydrogenation, solvent refining and controlled stabilization in the manufacture of national gasoline.

The technical problems are not yet solved, however, for but 25 per cent of the available oil is recovered by present means and many of the reserves such as shale are not at present worked commercially. Other countries with fewer reserves are, however, attacking this problem in different ways. Mining is a possibility, as is distilling the oil in the ground by controlled combustion.

Fear of depletion, periodically raised since 1861, is not imminent in this country as the proved reserves have been constantly increasing. It was stated that



Constitution Hall

oil actually removed from the earth so far would occupy less than one cubic mile.

Another factor which further minimizes the danger is the production of substitutes for motor fuel, either by blended alcohol or its production from coal. European countries faced with limited oil reserves have made encouraging progress along this line.

Coal reserves, adequate for 1700 or 2200 yr. places the danger of exhaustion too far in the future to cause serious concern. Yet the better coal reserves are being rapidly depleted in spite of advances in production and utilization methods. Prevention of these wastes is more an economic and academic than a technical problem. Due to the competitive character of the industry, comprising some 6,000 mines in 31 states and a huge excess capacity, the problem of regulation is made difficult.

If the industry can be established on a stable basis, states may be able to exercise their constitutional powers to regulate waste. An alternate proposal advanced was for the government to extend public ownership to the coal deposits and lease them to private operators for development, a system already in effect in the public lands of the far West.

Due to the competition of the fuels, coal, gas and oil, and to a limited extent water power, it is not unlikely that, at some future date, the allocation of production may involve not only the individual fuels but the highly complex and disquieting situation of making allotment between competing fuels.

World Power Conference

Section V

Special Problems in Regional Planning

Water Resources; Small Water Powers. Integration of Electric and Gas Utility systems.

CONFLICTING requirements of a civilization daily becoming more complex have been advanced as making the need for co-ordination of these requirements an immediate necessity. Development of power, navigation, flood control irrigation, industrial uses and wild life conservation are but some of the major factors involved in the planned utilization of the national water resources.

Three general methods of accomplishing this co-ordination are available: (1) Voluntary co-operation of private interests without aid or restrictions from political subdivisions; (2) complete development control and operation by the state or political subdivisions; (3) limited control by the state or political subdivision with certain rights and responsibilities resting with private interests. No single plan will fit all circumstances, but there seems to be, at the present time, a definite trend toward the second method, although this trend is, in many cases, against firmly established opposition, particularly when power generation is involved. The crux of the controversy appears to hinge on whether power be considered primary or incidental.

Looking at the question as a whole, it divides naturally into two parts: (1) That in which the solution is apparent and known, for instance, stream pollution; (2) that in which satisfactory solutions are not apparent. There seems to be agreement in that the first part is a matter for the state or political subdivision and there is, in this country, an inclination to consider the problem one for regional or geographical rather than state or political subdivison control.

The second part of the problem is more difficult, although the limited control under the Federal Power Act is a definite step toward regional predominance. The Tennessee Valley has been cited as an outstanding example of state, and Kanawha Valley as an example of state and private capital construction. A general solution for this country will probably never

be found and both of the above courses will probably be common in the future.

Small water powers, such as were responsible for our early industrial concentration, offer still different problems but, fortunately, these are not immediate and, in many cases, the solutions are apparent after the major developments have been completed. In this country the number of water wheels decreased from 55,000 in 1880 to 6,500 in 1929. In France the number of wheels has decreased by half, but in Sweden there has been an increase in about the same ratio from 1929 to 1935.

Interconnection of Systems

The third problem coming under the section on special planning dealt with the regional integration of electric and gas utility systems and many of the points were duplicated under the organization and regulation sections. By integration is meant the co-ordination or interconnection of systems primarily as a means of utilizing the diversity between different territories for the purpose of reducing excess capacity. Advocates of more complete integration add national defense as another major advantage.

The British Grid is an outstanding example. This national grid is owned and operated by the Central Electricity Board and is supplied with power by both private and publicly-owned plants. The grid and accompanying standardization of frequency cost about $182,000,000 and will ultimately be repaid by the industry. The budget is balanced on a 10-yr., rather than annual basis.

In France, substantially the whole country is now or will soon be interconnected under the general supervision of the Minister of Public Works, load dispatching being by a co-operating group of privately-owned corporations. Norway also has a completely co-ordinated system dominated jointly by the national government and privately-owned generating and transmission companies, distribution being largely in the hands of public bodies.

Gas Distribution Systems

Gas systems, also touched upon in other sections, have been built up to an appreciable extent in Europe for the distribution of manufactured gas over distances of 20 to 30 mi. Europe, however, has nothing comparable to the long natural gas lines in this country, the longest being the 1200-mi. line from Texas to Detroit. Growth of these lines, one single company having over 4000 mi. of large size lines connecting 32 fields with industrial centers, has been the result of necessity rather than planning.

It seems unlikely that the necessity for planned integration of gas systems more extensive than now exists either in this country or abroad will exist until all fuel production is co-ordinated under a single agency. The opinion of the gas companies, in fact, the opinion of all industries abroad seems well summed up in the statement of a British speaker to the effect that "the (gas) companies prefer to remain independent in the conduct of business." Inasmuch as a successful national integration can take place only when the demand exists, both inside and outside the industry, progress in this field appears to have little prospect of immediate success.

World Power Conference

Section VI

Rationalization of Distribution

RATIONALIZATION denotes the organization of an industry or business on an orderly basis to simplify procedure. There seems to be agreement that it will be greatly facilitated by substantial increases in customer usage but considerable difference of opinion as to how this may be accomplished.

The general contention that low rates in themselves bring about proportional increases in consumption is disputed by those with experience in that phase of the business and said to be true only within certain limits. Merchandising new equipment and the use of electricity where something else was used before was advanced as a more effective load builder.

When considering rural electrification and load building, the rate schedule itself was, however, given consideration as a major factor, at least in making rural electrification financially sound. Rate schedules are diverse and range from a straight line and flat rate schedules to complicated multi-part forms. The former are, however, on the decline and simple two-part schedules, attempting to take account of both the fixed charge and energy charge are more popular.

On the continent, particularly, rural electrification is well developed. Electrical service in France is said to reach 98 per cent of the population; in The Netherlands, 98 per cent; in Belgium, 99.83 per cent; in Switzerland, 98 per cent of the houses use electricity and in Germany 80 per cent of the agricultural holdings enjoy electrical service. In the United States, six million of the seven million farms are without electricity. International statistics in this regard are, however, misleading due to the territories involved and differences in definition of rural electrification.

Practices as to line extension policies and government loans or subsidies vary as widely as the rate structure. France, in particular has made extensive use of subsidies, ranging from 30 to 50 per cent of construction costs. Minimum guarantees are usually required.

Although the R. E. A. and T. V. A. hold the center of the rural electrification stage at present, the utility industry has for years been extensively cultivating this market in areas where the load density justified expansion. The utility opinion is that, if there is to be any radical increase in percentage of electrified farms, it must await some form of subsidy based on the intangible benefits of electricity in the home and not on its use in farm operations. As in power generating developments, the economic limit is clear.

World Power Conference

Section VII

National Power and Resources Policies

AS THE CONCLUDING section, intended as a general summary of the questions of policy discussed in previous sessions, this group of papers offered the greatest possibility of real dissension and is perhaps the most difficult to interpret. Papers were presented from eight nations and the delicate nature of the question may best be judged by the following comment of the general reporter.

"Generally the statements are formulated with a high degree of circumspection in consequence of which the reader may at times be puzzled as to what a particular national policy may be. No two papers approach the subject in the same manner, and it is not possible to bring all within a common frame of analysis."

This may be due to a natural hesitancy to speak freely on a delicate subject but various discussions would seem to indicate that the indefinite nature of the papers was due more to the fact that these policies are still in the formative stage and although definite efforts have been made in certain specific directions, no country, with the exception of Russia, has evolved a coördinated policy. What progress has been made is largely the result of haphazard growth and demands of national defense forcing the issue. As a peace time gathering of engineers, gathered together for mutual assistance, national defense was not mentioned, although it is difficult to understand how general national policies can be fully considered without bringing this skeleton out of the closet.

This opinion as to the indefinite nature of the problem is borne out by the absence of Great Britain from the nations represented by papers. With a definite policy, and several years' experience with coal, electricity and petroleum products, Great Britain should be in as good position as any nation in the world to advance a definite coördinated policy, yet her spokesmen were absent, conspicuously so after their active participation in the other sessions.

Many of the countries confine their primary interest to fuels. Thus Argentine's policy is confined to petroleum and is framed so as to prevent new activities by private companies and give control to the public agency. Austrian policy is in a state of flux and nationalization of power resources, entertained for a period, has been abandoned. Czechoslovakia has no unified coal policy even though 98 per cent of the energy used is from coal. Hungary, with sadly depleted fuel reserves, has a national policy in-so-far as it encourages conservation measures and private power development by subsidy and tax reductions. Sweden, where the state industry produces about one-third of the total energy, has been able to proceed amicably without definite policies established by legislation.

Efforts at a definite national policy are, therefore, as far as the papers presented in this section are concerned, confined largely to France and Germany. France, with a ministerial authority and council for the purpose, is not concerned with management of individual enterprises but with the broad problem of human and social factors, minimum excess capacity, justification for new plants, steam vs. hydro under particular conditions, interconnections, tariffs and a balance between these factors. Coal reserves are sufficient to remove any immediate concern but liquid fuel is a matter of some importance.

In Germany, too, the national policy is comprehensive covering reliability and flexibility of the supply, interconnection, increase and withdrawal of plants, rates, and stability of the industry. The function of the state is primarily supervision and regulation, not ownership. Gas has not been brought under as complete control because of technical difficulties in its relation to the coal and by-product industries. Fuel coördination is, however, the ultimate aim.

Although general conclusions from specific papers are difficult, the several general trends mentioned in the third paragraph of the editorial, "The World Power Conference," are evident from the congress as a whole.

As a nation taking a serious interest in national planning and policy for the first time, the American papers have been left until last for consideration for they add little of a practical nature to the discussion. One of the two American papers is a vigorous and capable defense of the private utility system, its accomplishments, intrinsic value and progressiveness. It advocates "laissez-faire" as a national policy and considers only power without relation to the more general problem of national resources.

From the one angle, the paper carries the weight of unanswerable arguments. Ninety-four per cent of the electric business of the country is done by private companies; during the depression, the stability, from both the financial and employment standpoints, of operating companies has been the envy of all other industries; unaided it prosecuted a vigorous and successful campaign to replace industrial load lost during the depression, with new domestic load; and for two gen-

Fig. 13. Delegates and guests of the Conference at Mt. Vernon, the historic home of George Washington

erations the close technical coöperation through trade associations made the industry supreme throughout the world.

Private Utilities Systems

Yet as a comprehensive treatment of the broad question of development of power resources and the extent to which policies are to be fixed by legislation or are subject to political change; also the degree to which individual policies are coördinated into a unified policy, and probable future trends, the paper falls short. Perhaps the most comprehensive statement from the utility side is that quoted on the editorial page of this issue.

If a sane government plan is adopted and a sound, definite policy outlined, there is no doubt that the private utility industry will coöperate for the public good, because no sound economic policy can possibly ignore the proper place of private business in such a program.

The second paper considers power as part of the general problem of conservation of natural resources, but attacks the problem from a purely theoretical standpoint. In agreement with the President's address quoted on the editorial page, the paper suggests that, as a guide to national policy, a scheme of "social accounting" must be developed to take care of those factors which are valueless to an industry but vital to the nation as a whole.

Proponents of closer co-ordination in this country propose operation by a Federal agency with national interest preponderant but with existing utilities, regional and local interests having an effective voice. Opponents in the utility industry point out that European systems based on comparatively small areas offer no counterpart to American conditions, also that already several networks in this country are larger than the British Grid. Examples of integration between different systems, for instance, the Cincinnati-Louisville interconnection, are pointed out to show that utility systems have already taken full advantage of this means of decreasing cost where it is economically justified, such interchange sometimes taking place on differentials as low as 0.15 mills per kw-hr.

Whether national planning becomes a reality in this country remains to be seen. There is undoubtedly a world wide trend in that direction and it is to be hoped that the permanent committee proposed at the Conference, for the purpose of international coöperation in settling power problems may materialize and carry the world forward gradually without disastrous mistakes in any one nation.

Privately owned companies now do 94 per cent of all the electric business in the United States and per customer rates of all utilities for all purposes exceed those of other countries except Norway and Switzerland. Even these two exceptional countries are rivaled by certain sections of the Pacific Northwest and the Niagara frontier. The financial stability of the utilities during the depression was unequalled in other industries and the utility spokesmen feel that the only way this stability can be retained to the ultimate good of both the industry and the public is for the government to sell the output of Federal projects to the utilities for transmission and distribution to both private and municipal systems.

ODD MOMENTS

A FAMILY of seven American Indians creating more interest among the delegates and visitors at the Smithsonian Institution than the exhibits, withal a credit to a proud race that once ruled the nation.

• • • •

The impressive entrance of President Roosevelt into Constitution Hall.

• • • •

The ability of newspapers to misinterpret the proceedings.

• • • •

The Washington Monument at night with its two red eyes—strangely like a tall and hooded ghost, unmindful of the gyrations of a small blimp.

• • • •

The universal approbation of the British delegation. Dignified, speaking well, and with authority, serious in carrying out the true spirit of the Conference, quick with a gentle but effective rebuke for those who transgressed, tolerant of the views of others and excellent company. They will be remembered as truly representative of the nation that sent them and the tradition of the Conference.

• • • •

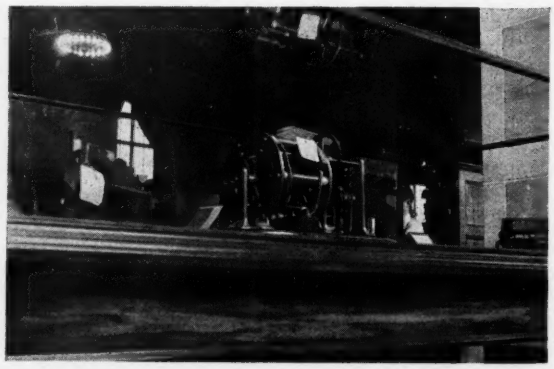
The quick and caustic rebuke by the chairman of the American Executive Committee of those few who forgot that politics were barred.

• • • •

Chairman Durand addressing the opening session in four languages.

• • • •

The inability to escape the candid camera which has practically replaced the larger and older Kodak.



1851 Motor model in the Patent Office

AWAY FROM THE CONFERENCE

The unbelievable progress in electrification and coordination of the U.S.S.R. as depicted in a 490-page book in English prepared for the Conference. Under complete nationalization they have solved, in their way, most of the problems discussed at the Conference and participated in the program briefly and with a mere recital of their accomplishments.

* * * *

An English Lord gazing intently at a folding camp bed used by George Washington and still on view at Mount Vernon.

* * * *

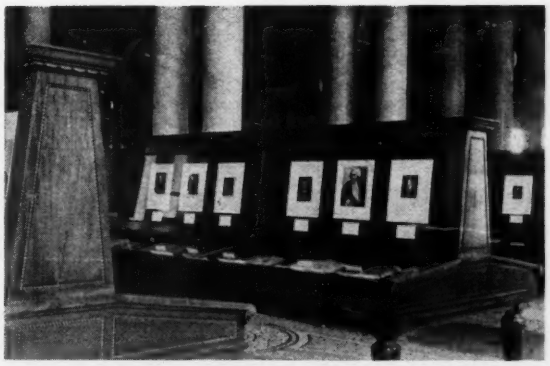
The Mount Vernon Mansion being prepared for a new coat of paint. The native pine boards were cut to resemble stone and covered by the Washingtons with a mixture of paint and sand resembling stucco.

The Government Auditorium

Two Americans with the will but not the ability to explain to a German that a joking remark about a machine gun was not to be taken seriously.

* * * *

The wonderful exhibit of old manuscripts on power, military and mechanical engineering on display at the Library of Congress. Publication dates of 1500, 1600, 1700 and 1800 in great profusion by authors such as Coulomb, Carnot, Bacon, Vitruvius, Besson, Gilbert and others whose names are now tradition. Valluri's, De re militari of 1472 was the second illustrated book printed in Italy. Looking over the books shown, the present generations have, excluding electricity, simply improved on the ideas of their elders and have been able to do this only because of the improvement in materials.



Old power book exhibit in Library of Congress

A model of patent No. 7,889 issued to Jacob Neff, January 7, 1851, on an "electro-magnetic engine," an attempt to use electro magnets to make a practical motor.

* * * *

A taxi driver apologizing for being in Washington only a month and not yet knowing the names of all the statues.

* * * *

A guard in the National Academy of Science warning a visitor that cameras were taboo and all the guards wore rubber heels.

* * * *

Two dignified and serious minded matrons trying to catch a glimpse of the electrons as they flashed from grid to plate in a huge amplifying tube and giving up in disgust because the bluish glare obscured their vision.

* * * *

A small girl keeping a list of countries represented and disgusted because but 31 of the reported 55 could be located.

* * * *

A teetotaler unconsciously enjoying a mint julep at the Garden Party at the Bliss Estate.

* * * *

The absence of coal and oil men at the conservation and planning sessions.

* * * *

The astounding statement that 100 per cent octane rating gasoline can be produced by a new process without doping and that the efficiency of the gasoline motor can be raised to that of the Diesel.

SECOND

Lights and shadows inside the scroll case of the Norris Dam Turbines. (Photo, courtesy T.V.A.)

THOSE MAJESTIC water retaining bulwarks of concrete called dams, to quote the press release, received their share of attention at five technical sessions. Although an opening had been provided under Sections I and II of the World Power Conference program for technical developments, this possibility was overlooked by all the National Committees and not a single technical paper was presented. As a consequence, the sessions on Large Dams partook more of the nature of a technical convention and the discussion there was, by comparison at least, spirited.

Thirty-six papers on the five general questions submitted were, as in the other sessions, read in composite abstract form only.

Special cements to meet the demand for low heat of hydration, high resistance to aggressive waters and disintegrating agents and reduced tendency to crack have been developed for massive concrete structures, due presumably to the trend of development of normal cements toward higher early strength and attendant higher heats of hydration. Work on this has been general throughout the world but, due to the recent work on large government projects, America has taken the lead in practical application.

Design and waterproofing of shrinkage, contraction and expansion joints, all matters of important detail, developed differences of opinion. In the main, contraction (as distinguished from shrinkage) joints are advocated, and metal plate sealing joints favored over asphalt. These papers do, however, differ so widely and deal with a comprehensive question so thoroughly that no general summary can be made.

Facing Methods

Facing of masonry and concrete dams to prevent percolation, as well as damage by ice and debris, is a question of import, particularly in Europe. Practice is not standardized, bituminous coatings, mortar fac-

ings, metal plates, special cements and mixes, and stone facings are used in different locations. The greatest difference of opinion appears to be between southern and northern Europe over the advantages of and necessity for stone facings. In the south this type of construction is favored, while, in the north, particularly in Sweden, it has been a failure and is being abandoned because it cannot be kept in place. In America, the problem is not considered so important. Good concrete well placed seems to be entirely satisfactory and this apparently will be the future trend in Europe as well.

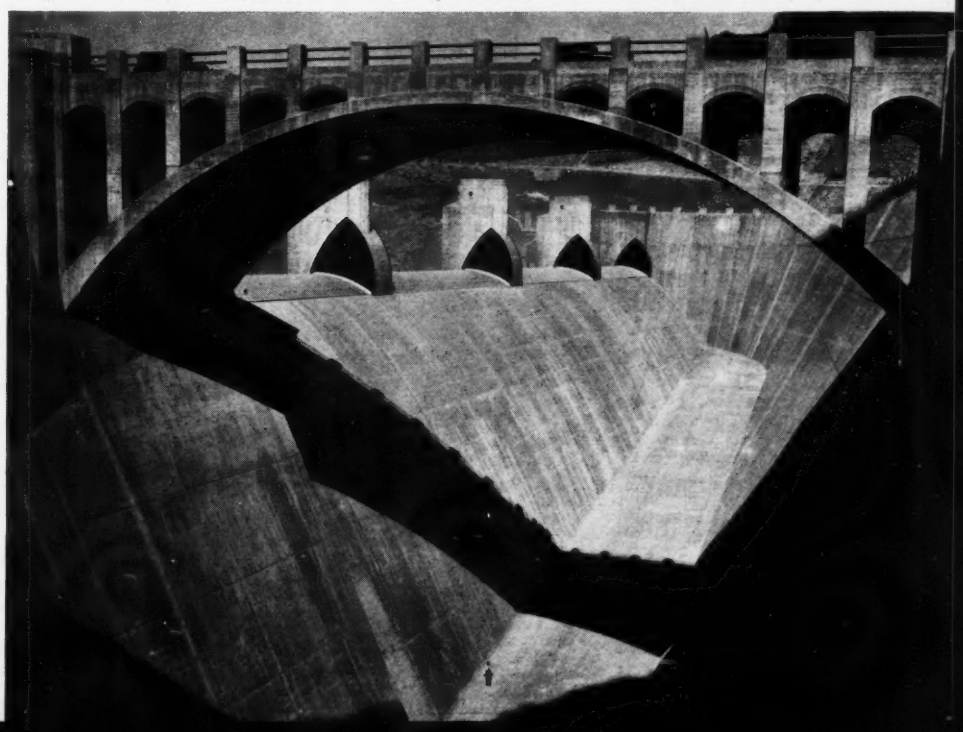
Foundations and Stability

Geotechnical studies of foundation materials and the application of tests and experience in the investigation of dam sites emphasize the need for coöperation between the geologist and engineer, test pits, shafts and geophysical prospecting, with appropriate chemical and physical tests to determine the character of the foundation material. Rule of thumb methods cannot be developed for this work, however, and generalizations and classifications capable of universal application were cited as dangers to be guarded against. The most valuable parts of the papers dealt with case studies of particular jobs.

Calculation of the Stability of Earth Dams was covered by a group of 15 papers, highly mathematical and based on different methods of approach. The stability of slopes was the most popular topic and two papers with original treatment of stresses advanced new thoughts which offer possibilities in practical achievement. In general, the papers treated the subject in accordance with the well-known method of the most dangerous sliding slope. The cylindrical surface was adopted by the majority but cycloidal, logarithmic and special planes were mentioned as possibilities, although generally considered as improbable or as an unnecessary refinement.

The external forces acting on a segment of a dam bounded by the face and assumed sliding plane may be considered as the dry weight of the material and the force of the water. This latter consists of the gravitational force, the buoyant force and the seepage-frictional force. Different methods combine these forces differently to obtain identical results. Three distinct types of diagrams, the flow net consisting of equipotential and stream lines, lines of equal pressure, and lines of equal resultant pressures of all forces below the phreatic line are favored by different nationalities.

When an international convention comes to the consideration of such details of design and construction as covered in the five sessions, the subject may be considered well in hand. The only major question still offering difficulties is the matter of foundation investigations which is still somewhat of an art because conclusions must be drawn from tests and samples of a small part of the whole, with no assurance that these test specimens are truly representative.



The Arizona spillway at Boulder Dam is large enough to dock America's largest battleship. This view, looking upstream, shows the highway bridge crossing the spillway channel. Note the man standing in the bottom of the channel. The Arizona spillway is duplicated on the Nevada bank of the Colorado river above the dam. These great channels provide protection for the dam from sudden rises in the river. Together they are capable of by-passing 400,000 sec. ft. of water. The greatest known flood on the river totaled 250,000 sec. ft. (Photo, Bureau of Reclamation)

BY resort to Fuel Analyses and mathematical formulas, the engineer has a safe guide for the operation of his boiler furnaces.

Heat of Combustion Calculated from Fuel Analyses

By J. R. DARNELL

Consulting Engineer, Jenkins Petroleum Process Co.

IN CALCULATING combustion losses, if an ultimate analysis is not available, one that is fairly representative may be selected from Bureau of Mines tables by choosing the accompanying ultimate analysis of a proximate analysis most nearly corresponding to the fuel in question.

If so desired, an ultimate analysis may be calculated from the proximate analysis. Various text books on combustion and power plant practice offer formulas for such calculation but most of these are unsatisfactory and cannot be relied upon.

Sulphur in the coal increases the value of the volatile matter and upsets calculations for ultimate carbon.

If the ultimate analysis is already known or has been calculated, but the heat value has not been determined, it may be calculated with a fair degree of accuracy by Dulong's formula:

$$\text{B.t.u.} = 14{,}550\,C + 62{,}000\,(H - O/8) + 4050\,S$$

where C is carbon, H hydrogen, O oxygen and S is sulphur.

This, however, does not apply to high oxygen fuels such as lignites, sub-bituminous coals, and wood refuse.

Dry Gas Loss

With both the ultimate carbon and the amount of carbon in the refuse known, the dry gas loss may be calculated from the following equation, if an analysis of the flue gas is known:

$$\text{Weight of dry gas per lb. fuel (as fired)} = \frac{4CO_2 + O_2 + 700}{3(CO_2 + CO)} \times (C - C_r + S/1.83)$$

Where C is the ultimate carbon in the fuel and C_r is the carbon in the refuse, calculated as a per cent of 1 lb. of fuel, and S ultimate sulphur.

$$\text{Loss in B.t.u. per lb. fuel} = W \times 0.24\,(T_g - T_a)$$

Where, W = lb. dry gas per lb. fuel
0.24 = specific heat of air
T_g = temperature of flue gas
T_a = temperature of air

Moisture and Hydrogen Loss

The loss due to moisture and hydrogen usually is calculated in one step if the ultimate analysis is really "ultimate", i. e., with the moisture divided into hydrogen and oxygen. This is the method usually employed in analyses given by the Bureau of Mines. When calculating the loss due to moisture and hydrogen in the fuel, if the analysis is given in this manner only one step is necessary as shown in the following equation: Loss due to moisture and hydrogen, B.t.u. = $9H[(212 - t) + 970.4 + 0.46\,(T - 212)]$ where H is the "ultimate" hydrogen, t is room temperature and T the flue gas temperature.

Loss due to carbon in the refuse is calculated by the equation:

$$\text{Loss in B.t.u.} = \frac{C \times A}{1 - C} \times 14{,}600$$

where C is the carbon in the refuse, dry basis, and A is the ash in the fuel, dry basis.

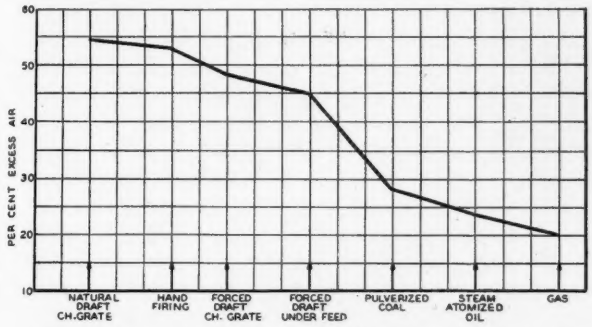
Loss due to incomplete combustion usually is small, and for most general purposes may be neglected.

The curve herewith shows the average excess air at best operating conditions with different types of fuel

burning equipment. See article by E. G. Bailey "Limiting Factors in Reducing Excess Air in Boiler Furnaces" —Mech. Eng., July, 1926.

Calculation of Flame Temperature or Gas Weights

Assume that it is required to determine the weight of products of combustion with a flame temperature of 2400 deg. F. when burning Illinois coal, assuming complete combustion, no radiation loss, and no dissociation.



Average Per cent Excess Air for Best Operating Conditions

If 2400 deg. is the theoretical flame temperature, the weight of the products of combustion per pound of fuel burned may be determined as follows:

$$\frac{\text{B.t.u.}}{T \times H} = 1.0$$

T = flame temperature, deg. F.
H = total heat of products of combustion from 1 lb. of fuel between temperature of the fuel and air and the flame temperature.
B.t.u. = heat value of fuel, as fired, in British thermal units.

Assuming the burning of Illinois coal, with the analysis as given in the table herewith, by a trial and error method, the assumed pounds of gas per pound of fuel may be checked as follows:

$$\frac{10{,}960}{2400 \times H} = 1.0$$

H = weight of products multiplied by mean average specific heat.

Table I—Analyses of Representative Fuels as Fired

	Proximate				Ultimate					
	Moist.	V.C.M.	F.C.	Ash	C	H	O	N	S	B.t.u. per lb.
Fuel Oil	--	--	--	--	84.0	12.7	1.2	1.7	0.4	18700
Eastern Bit.	3.2	31.0	59.3	6.5	79.9	4.9	6.7	1.3	0.7	14300
Pittsburgh Bit.	1.8	31.0	57.2	10.0	74.0	5.2	8.0	1.4	1.4	13400
Illinois Bit.	10.0	34.8	42.0	13.2	58.6	5.8	23.9	0.9	3.4	10960
Wood Refuse	46.1	--	--	0.2	27.2	3.5	64.2	--	--	4940
Rice Anthracite	4.6	3.7	71.7	20.0	70.2	1.9	6.8	0.2	0.9	11650
Refinery Gas	--	--	--	--	77.6	19.0	0.6	2.8	--	22100
Natural Gas	--	--	--	--	67.5	22.2	--	5.8	--	21540

The mean average specific heat of the various products of combustion can be determined only by assuming a given percentage of excess air, calculating the specific heat value and substituting in the above equation.

In the foregoing example let us assume 6.5 per cent CO_2, corresponding to 180 per cent excess air.

The average specific heat of the various gases between 60 deg. F. and 2400 deg. F., as found in Pratt's Principles of Combustion, page 32, are:

CO_2 0.2338
O_2 0.2270
N_2 0.2472
H_2O 0.4840

Then, to find the mean average specific heat for the total products we find the weight of each gas and then multiplying this value by the average specific heat, we find the total B.t.u. put into the total products of combustion:

	Weight of Products		Average Specific Heat		Heat in Products
CO_2	1.759	×	0.2338	=	0.411 B.t.u.
H_2O	0.518	×	0.4840	=	0.251 B.t.u.
O_2	1.803	×	0.2270	=	0.410 B.t.u.
N_2	14.545	×	0.2472	=	3.600 B.t.u.
	18.327 Lb.				4.672 B.t.u.

Then, the mean average specific heat is

$$\frac{4.672}{18.327} = 0.255$$

Accordingly, if the above amount of excess air and its resultant gas weight has been the correct value to assume, the equation should come very close to balancing. If it does not, a higher or lower excess air value should be chosen. If the value arrived at is greater than unity, the excess air assumed was too low, if less than unity, the excess air was too high.

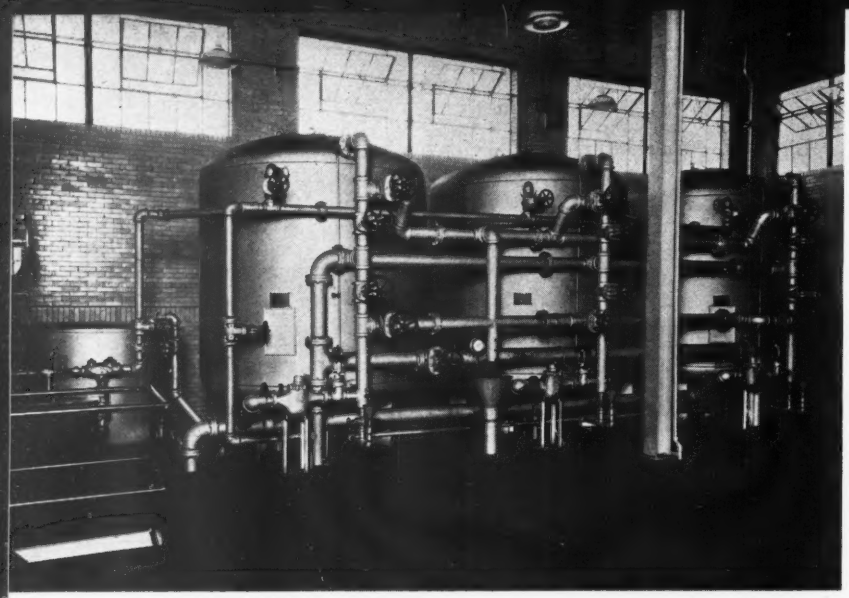
Table II—Assumed Analysis of Illinois Coal

	PROXIMATE			ULTIMATE	
	As Rec'd.	Dry		As Rec'd.	Dry
Moisture	9.95	0.00	Carbon	52.80	58.60
V.C.M.	34.76	38.55	Hydrogen	5.75	5.15
F.C.	42.07	46.75	Oxygen	23.88	16.72
Ash	13.22	14.70	Nitrogen	0.92	1.02
	100.00	100.00	Sulphur	3.43	3.81
			Ash	13.22	14.70
B.t.u.	10,960	12,150		100.00	100.00

In the above example

$$\frac{10960}{2400 \times 4.672} = 0.975$$

This shows that a temperature of 2400×0.975 or 2340 deg. would have been obtained with 18.33 lb. gas per lb. of coal. This is close enough for all practical purposes but if more exact calculations were necessary we could proceed in the same manner by assuming, say, 7.0 per cent CO_2 and its corresponding gas weight and then working through again on this basis. This would show a value greater than unity, so that we could assume that the correct gas weight would lie at a point between 6.5 and 7.0 per cent CO_2. But as it is not possible to read an ordinary water Orsat apparatus closer than to ½ per cent we can assume that our first assumed value of 18.3 lb. gas per lb. of coal is as close as practical observations will permit



Triple unit Zeolite Softener for use in preparation of make-up for a modern 600 lb. pressure steam generator

Feedwater

BOILER FEEDWATER TREATMENT has always been a live subject with boiler plant operators. Back when 150 lb. per sq. in. was considered a high pressure, the aim of a good operator was to maintain clean evaporating surfaces in order to eliminate mechanical cleaning and to increase boiler efficiency. Although extravagant claims as to savings that could be accomplished at the coal pile were made for various proprietary articles, with the better knowledge of feedwater chemistry now general, most of them have fallen into disrepute and are no longer considered seriously. While it is true that scale retards the transfer of heat, which is in a measure reflected in the coal pile, the older claims of big savings were often exaggerations. Actually, the principal purpose of correct feedwater conditioning, besides the elimination of mechanical cleaning, is to prevent tube losses when operating boilers at high ratings and at high pressures.

Because of the heavy duty imposed upon the tubes in the transfer of heat, even a thin scale cannot be tolerated on the evaporating surfaces of modern high-pressure, high-rating boilers. At the rates of steam generation per hour per square foot of surface practiced in most modern boilers, scale of sufficient thickness to increase the temperature and cause failure of the tube metal will crystallize out in an inappreciable time if the water is not properly conditioned. Figure 1, from University of Michigan Engineering Bulletin No. 15, "Formation and Properties of Boiler Scale," by E. P. Partridge, shows graphically the effect of pressure and the temperature differences that can be tolerated between the tube and the water within.

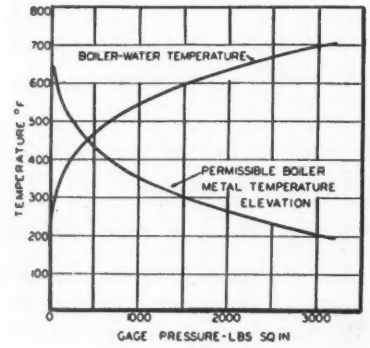


Fig. 1. Effect of pressure and the temperature difference that can be tolerated between the tube and the water within

It is quite evident that high pressures demand cleaner surfaces than do low pressures, and the more sensitive reaction of boilers at the higher pressures and ratings to variations in feedwater treatment has forced the water treatment industry to meet new conditions. The complex structure of a modern high capacity, high pressure boiler is reason enough why plant designers refuse to compromise with the feedwater problem.

The treatment of feedwater is a matter of conditioning rather than merely softening, and many factors must be taken into consideration when selecting the type of treatment to be applied to any particular water supply. The writer well recalls an instance which demonstrates this fact very clearly. A plant in Ohio operated four boilers with untreated water relatively high in hardness, and as a result the boilers became badly scaled. The plant ran along smoothly, however, except that mechanical cleaning was necessary at frequent intervals. In order to care for expanding manufacturing facilities, four new boilers were installed alongside the old ones and, at the same time, a softener was installed. Unfortunately, this type of softener was unsuitable for the water and the four new boilers became embrittled within 16 months, whereas the old boilers had been entirely free from embrittlement. The clean surfaces resulting from the use of softened water allowed the caustic to attack the seams, resulting in failure. In the old boilers the scale formed a barrier to this attack and they consequently were protected. Subsequently the water conditioning system was changed over to a different type, in which were fulfilled the A.S.M.E. recommendations for control of embrittlement, and no adverse results are observable after approximately five years' operation. The boilers affected by embrittlement have been replaced by duplicate boilers of the same manufacture. This experience demonstrates two important facts, namely, that the maintenance of clean evaporating surfaces may in itself create new problems, and that the type of feedwater treatment must be selected with care. In other words, water conditioning must take into account the water problem as a whole, of which prevention of scale is only one phase.

When the water problem has been solved comprehensively, the water may be said to be "balanced".

Treatment for Modern Steam Generators

By
CHARLES E. JOOS
Manager, Water Treatment Division, Cochrane Corp.

Such a feedwater treatment should meet the following basic requirements:

1—Maintenance of clean evaporating surfaces:
- By reducing dissolved calcium and magnesium salts to low limits.
- By preventing the formation of adherent sludge and scale in boilers.

2—Protection against corrosion of economizers and boilers:
- By maintaining the proper pH values and low content of oxygen.

3—Prevention of carry-over:
- By reducing and controlling solids and alkalinity, whereby foaming and priming tendencies are kept at a minimum.

4—Protection against embrittlement:
- By maintaining suitable sulphate-carbonate ratios, as recommended by the A.S.M.E.

5—Low costs:
- For installation.
- For operation.

These requirements can be met in various ways, and the purpose of this paper is to indicate how a rational selection can be made from the various methods available. Only external treatment will be considered.

There are three methods of external treatment, namely:

1—By evaporator.
2—By hot process lime and soda softener using
- a—Lime and soda ash.
- b—Lime-soda ash and supplementary phosphate in the boiler.
- c—Softening by phosphate externally to the boiler.
- d—Lime-soda primary treatment and secondary phosphate softening in a separate sedimentation tank.

3—Zeolite
- a—Without pre- or post-treatment.
- b—With pre-treatment with lime.
- c—With post-treatment with acid.

Evaporators

Evaporators are not generally well suited to industrial plants because of the high initial investment and the degradation of heat unavoidable in their operation, which results in high operating costs. The cost because of degradation of heat in operating evaporators is easily understood by reference to Fig. 2. In the transformer type evaporator used in industrial plants, steam at a relatively high pressure is used to produce process steam at a somewhat lower pressure. For example, if a paper mill requires steam at 30 lb., the evaporator will receive steam at 50, 60, 70 or 100 lb. per sq. in., depending upon the size and type of machine. This means then that in order to have only pure distilled water for boiler feed, it will be necessary to bleed a turbine at, let us say, 100 lb.

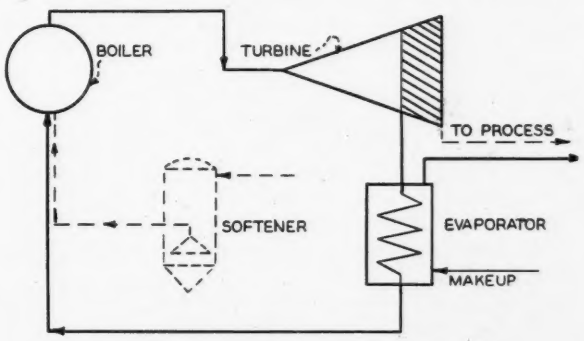


Fig. 2. Diagram showing power loss by evaporator

per sq. in. for the production of 50 lb. vapor, thereby losing the power that could have been generated by the expansion of this steam from 100 to 50 lb. per sq. in., as shown by the shaded area.

Fig. 3 shows the power sacrificed because of various differences in pressure between inlet and outlet of the evaporator. This loss of power, calculated to dollars and cents, makes the installation of evaporators prohibitive for industrial work.

Prior to the demonstration of the results now practicable with softeners, evaporators were installed for some extremely high pressure plants, notably those of the Philip Carey Mfg. Co., Lockland, Ohio; the Ford Motor Co., Rouge Plant, near Detroit; and the Firestone Tire & Rubber Co., Akron, Ohio. When selecting evaporators the designers of these plants knew that they were sacrificing economy, but felt justified in view of the pure feedwater to be had. Current practice has

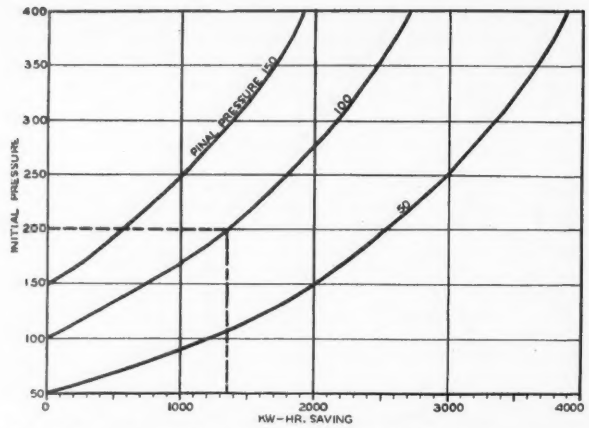


Fig. 3. Power obtainable by expansion of 100,000 lb. of steam per hr.

removed any doubts as to the practicability of using softened water for makeup, even for the highest pressures in use today. In some of the installations just mentioned, the use of softened water instead of distilled water as makeup might have enabled the designer to select boilers for 600 or 800 lb. pressure instead of much higher pressures, thereby reducing the cost of installation. To illustrate the confidence that designers now have in the modern methods of the water conditioning art, at the present time the Weirton Steel Co., Weirton, W. Va., is placing in service a 900 lb. boiler to use 100 per cent makeup treated in a hot process softener with supplementary phosphate. Designers of very high pressure plants may well give serious consideration to softened water as makeup by which degradation of heat can be eliminated while achieving the desired protection for the boilers.

Where makeup requirements are only 1 or 2 per cent and where the reduction in heat economy is infinitesimal in comparison with the total cost of operation of the plant, as in central stations, it is not likely that evaporators will be displaced as the favored method of treatment. For industrial requirements, however, two methods remain, namely: the zeolite process and the hot lime and soda process. To decide as between these two systems we must take into account both the chemical composition and the physical characteristics of the water supply. Water supplies may be classified as follows:

1—Turbid.
2—Clear.
3—High hardness:
a—High carbonate.
b—Low carbonate.
4—Low hardness:
a—Low carbonate.
b—High carbonate.

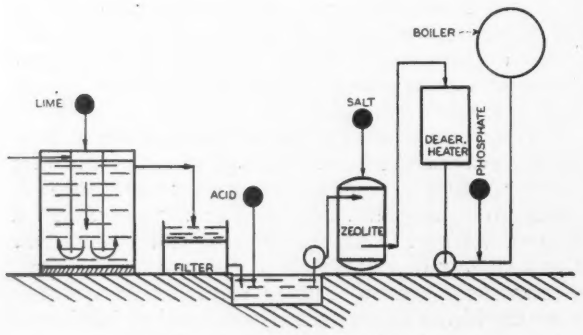


Fig. 4. A lime zeolite plant

As a typical example let us select a high carbonate, high hardness water characteristic of the Central West. First, it is well to tabulate the analyses of the treated waters to be obtained by the two principal systems, as shown by Table I.

From the table it will be seen that the hot process lime and soda softener gives a "balanced treatment". The hardness is reduced to a very low degree, although not so low as with zeolite softening. In a hot process softener hardness is a function of excess sodium carbonate used, and can be reduced by increasing the chemical dosage. The embrittlement ratio is satisfied, the alkalinity is comparatively low and there is a substantial reduction in solids; in other words, all requirements of a proper treatment are satisfied. The zeolite system of itself does not reduce the solids, but instead they are increased, while the alkalinity is excessive, the embrittlement ratio is not satisfied and the cost of treatment is high. In other words, the hot process softener is the rational choice in this case.

Table I. Comparison between Lime soda treatment and Zeolite treatment of a high carbonate water

Substance	Raw Water	Treated by Hot Process	Treated by Zeolite
Calcium carbonate	8.11	1.00	0.30
Calcium sulphate	5.19	....	....
Magnesium carbonate	5.54	0.20	0.20
Magnesium chloride	0.53	....	....
Silica	0.35	0.14	0.35
Iron oxide and alumina	0.06	0.02	0.06
Sodium carbonate	....	1.50	15.60
Sodium sulphate	....	5.43	5.43
Sodium chloride	1.92	2.45	2.45
Volatile and organic	1.81	0.72	1.81
Total Solids	23.51	11.46	26.20
pH	7.5	9.6	7.5
Sodium sulphate to Sodium carbonate ratio		3.62/1.00	1.00/2.87
Blowdown required		7.6%	17.5%
Cost of treatment per 1000 gallons		3.63c	7.3c

In order to bring about a balanced treatment with the zeolite system, it is necessary either to pre-treat the water with lime or to afterward treat the zeolite softened water with sulphuric acid. In Fig. 4 this is accomplished by the use of a cold process softener sedimentation tank followed by filtration and partial neutralization with acid, then zeolite softening and deaeration. The acid feed in this case is necessary in order to reduce the alkalinity or pH value of the lime softened water for protection of the zeolite mineral. Fig. 5 shows how this water might be corrected by the use of sulphuric acid alone. This method does not give as good results as does the lime pre-treatment, for instead of the solids being reduced they are increased. The water is made intensely corrosive by the addition of acid, which is likely to lead to corrosion of feedwater heater, feed lines and possibly boilers. However, there are a number of plants which employ this type of treatment satisfactorily.

It is clear that for such a water supply the instal-

lation of a hot process softener enables us to bring about a balanced treatment in the simplest possible manner and with the least installation and operation expense.

Now, as another example, let us take a water that is high in hardness and low in alkalinity, as for example that obtained in the Pittsburgh district. Again setting up the expected analyses, as shown by Table II, it will be observed that in this case the zeolite softener enjoys a decided advantage, not only in the cost of treatment, but also, since the water is clear to begin with, in the cost of equipment itself.

For water of this character available in a filtered condition, authorities on feedwater conditioning may favor zeolite softening, plus proper deaeration to prevent corrosion. The photograph at the head of this article illustrates a triple-unit zeolite softener serving for the preparation of makeup for a modern 600 lb. pressure boiler. Supplementary phosphate is introduced for complete protection against silicate and other types of scale. If, on the other hand, with water taken from a river, the physical characteristics may require an elaborate preparation system ahead of the zeolite softener, the hot process would be advantageous because of the simplicity and low cost of the apparatus, in which clarification, heating and softening are combined. Thus even the chemical characteristics alone of the water are not sufficient to determine the type of softening system that should be applied.

With high steam pressure, that is, 250 lb. per sq. in. and above, the feeding of phosphate as a supplementary treatment is essential to the maintenance of clean

Table II. Comparison between lime-soda and zeolite treatments of a high sulphate water

Substance	Raw	Hot Process	Zeolite
Calcium carbonate	....	1.00	0.30
Calcium sulphate	6.30	....	....
Magnesium carbonate	0.87	0.20	0.20
Magnesium sulphate	0.41	....	....
Silica	0.12	0.05	0.12
Iron oxide and alumina	0.12	0.02	0.12
Sodium carbonate	....	1.50	1.08
Sodium sulphate	0.47	7.50	7.50
Sodium chloride	1.46	1.46	1.46
Volatile and organic	2.80	1.12	2.80
Total Solids	12.55	12.85	13.58
pH	6.8	9.6	6.8
Sodium sulphate to Sodium carbonate ratio		5.0 to 1	6.95 to 1
Blow down required		8.5%	9.0%
Cost of treatment per 1000 gallons		2.34c	2.28c

evaporating surfaces. The feeding of phosphate supplementary to zeolite and hot process softeners was practiced as early as 1926 and since that time many hundreds of installations have been made, with entirely satisfactory results. In the high pressure field, we have plants operating at pressures as high as 800 lb. per sq. in., with makeup ranging from 5 to 100 per cent. The low alkalinity of the boiler water obtainable with phosphate serves to reduce the solids to a minimum, minimizing foaming and priming tendencies, and makes it easier to establish the 3 to 1 embrittlement ratio demanded at these pressures by the A. S. M. E. Code. The phosphate treatment has, therefore, encouraged power plant designers in the use of higher pressure where evaporated makeup is not available or desired.

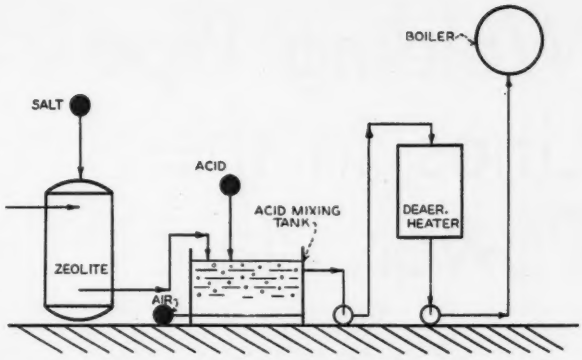


Fig. 5. A zeolite-acid plant

The above examples demonstrate clearly the need of looking upon water conditioning equipment in all its aspects and of making the selection rationally. The selection of a zeolite system for the water shown by Table I would have resulted in an expensive and probably troublesome installation, although the water so softened would not have deposited scale in the boilers. The need of treating the water to a "balanced" condition cannot be overemphasized.

EDITOR'S NOTE: This is the first of two articles on this subject by the author. A second, dealing with new developments in the treatment of feedwater, will appear in a subsequent issue.

FEDERAL POWER COMMISSION, by direction of President Roosevelt, is to begin a study to determine wholesale rates for electric energy to be developed at Bonneville Dam in Oregon. As such study will take time and it is desired to present to the next session of Congress a bill authorizing sale of power at rates and under contracts approved by the Commission, also to authorize construction of transmission lines, the President desires that the study be started immediately to avoid delay in making contracts after legislation is enacted. National Resources Board has suggested a grid system of transmission lines and a rate structure tending to distribute power as widely as practicable rather than concentrate use near the generating plant. Chairman McNinch of the Commission states that it is planned to complete the study and submit the report on rates by the time that Congress is convened. Neither dam nor generating plant is yet completed, nor is the transmission system contracted for.

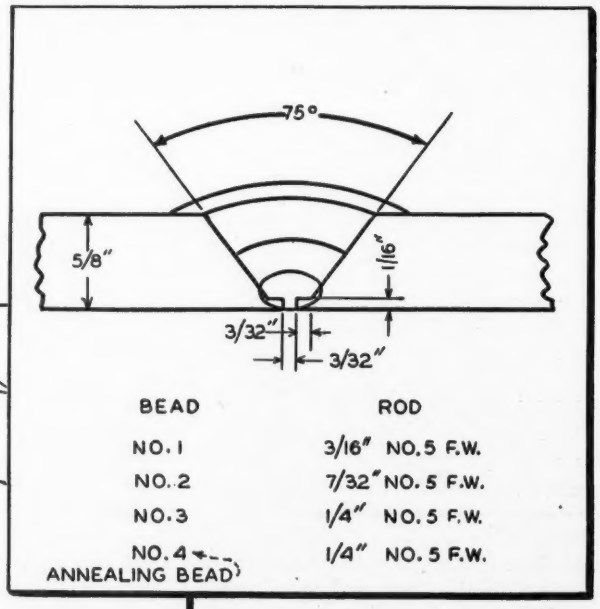
ECONOMIES resulting from the weight-saving features of high-strength alloy steel are strikingly illustrated in the recent construction of a power transmission line in a mountainous section of West Virginia, as related in the Electromet Review. The site was substantially a wilderness, far removed from railroads and devoid of roads other than mountain trails. Hence a considerable proportion of the expense of construction was that incurred in delivering the transmission tower material. Through the use of alloy steel, however, the weight of the heavy corner angles of the towers was reduced approximately 30 per cent, with a corresponding saving in the expense of handling the material over the rough terrain.

Welding Pipe Lines in the Power Plant

IN RECENT YEARS the erection of high-pressure, high-temperature piping has been greatly simplified by the use of arc welding methods. By the elimination of a mutiplicity of parts the electric arc welding process simplifies installation as well as piping design, and provides a permanently tight system, low in resistance to flow because of the absence of projections inside the pipe.

One of the most recent instances of the use of electric welding in erecting piping is the new system installed at the Alton Box Board and Paper Co., Alton, Ill. The system was furnished by the Midwest Piping and Supply Co., St. Louis, Mo., and erected and fitted by the Alton Box Board and Paper Co., and all the welding was tested in accordance with the specifications of and was insured by the Hartford Steam Boiler Insurance and Inspection Company.

Fig. 4 shows a portion of the 10-inch diameter steam header line designed to carry an operating steam pressure of 475 lb. at 750 deg. F. (600 lb. construction)—to be used in conjunction with a new steam turbine. The wall thickness of these pipes is 5/8-in. The illustration shows (on the left) a



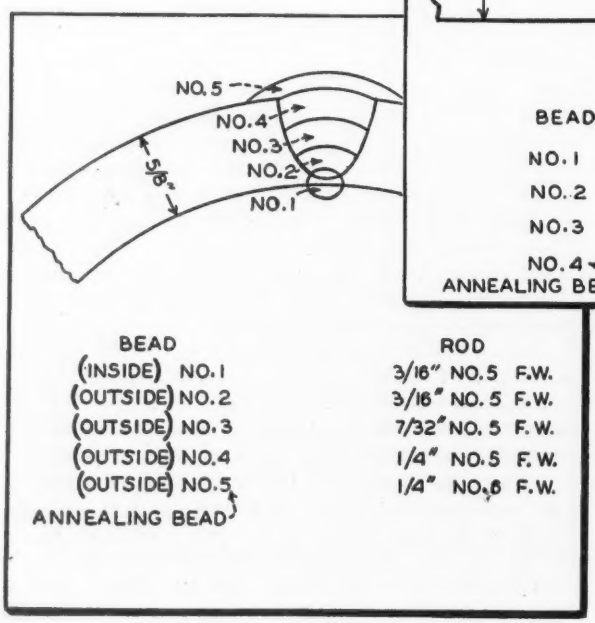


Fig. 1. Above. Details of weld used in welding 10 in. diameter, 475 lb. pressure, 750 deg. steam line.

Fig. 2. Left. Details of a positioned prefabricated elbow weld.

Above is shown an air chamber being welded by the electric arc process. This air chamber is to be operated at a pressure of 650 lb. in connection with the boiler water conditioning system. (Photos and drawings, courtesy Lincoln Electric Co.)

positioned prefabricated elbow weld. This weld is detailed and described in the sketch, Fig. 2. As indicated, the first bead was made inside the pipe with the pipe butted together. After the bead was completed the U-shaped groove was machined out from the outside as shown. Then beads Nos. 1, 2, 3, 4 and 5 were made in downhand position by rotating the work. Immediately to the right of the elbow weld shown in Fig. 4 is a positioned circumferential pipe weld. Details of this weld are given in the sketch, Fig 1. The machining of the 75 deg. notch was done prior to running in the first welding bead. In making the weld, consisting of four beads, the work was rotated to permit continuous downhand welding.

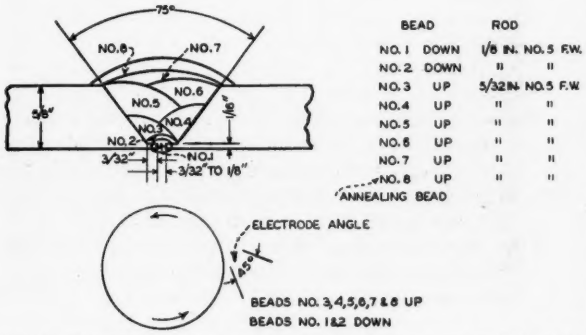


Fig. 3. Diagram showing procedure for making circumferential welds on location

The two circumferential welds, shown at right of Fig. 4, were made on location. The procedure for making these welds is given in Fig. 3. The first two beads were applied by starting at the top of the pipe and welding down on either side, stopping at the bottom. The last six beads were applied by using the opposite procedure, from bottom up on both sides.

It will be noted that the welds are built up. The purpose of this is not for strength, but to anneal the weld and the pipe metal adjacent to it.

The electric welding of the new piping at the Alton Box Board and Paper Company was done with the latest shielded arc equipment supplied by The Lincoln Electric Company, Cleveland, Ohio. Lincoln "Fleetweld" electrodes and new "Shield-Arc" welders.

Fig. 4. Portion of the 10 in. steam header line. (Photo, courtesy Lincoln Electric Co.)

Steam Electric Locomotive for Union Pacific

ANOTHER PAGE in the rapidly accelerated history of modern railroading will be turned early next year with the appearance on the Erie, Pa., test tracks of the General Electric Co. of a new steam-electric locomotive which is being built for the Union Pacific Railroad.

This new passenger unit will carry a condensing steam turbine generating plant feeding electric power to traction motors. Radically different in design from any locomotive now in service—of either steam or electric type—it will eliminate two of the colorful characteristics of the steam-railroading days—the side-rod drive and the water tower. Electric power will drive traction motors constructed on the usual electric locomotive design, and the turbine will operate condensers using the same water over and over, with small additions to make up for leakage. The problem of picking up water is thus largely done away with, and clean distilled water will insure long life and permit long runs without boiler repairs.

The many desirable constructional features of the modern high-speed electric locomotive will be incorporated in the design as a result of General Electric's many years of experience in building this type of unit. Because of fundamental differences it is expected that the new locomotive will show a great reduction in fuel consumption and a correspondingly low maintenance.

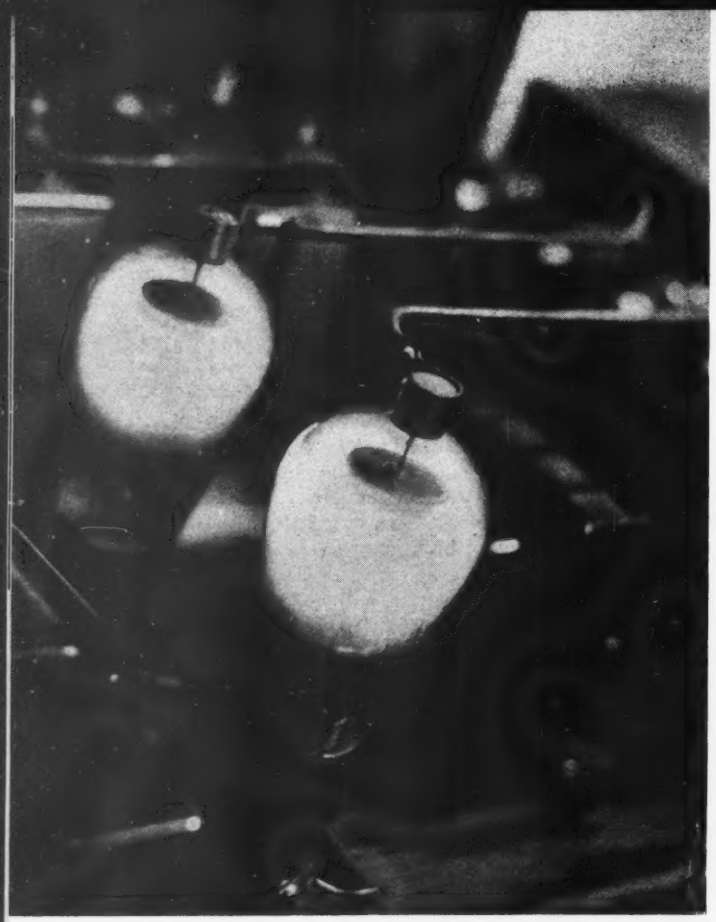
The new unit will be a double-cab locomotive, rated at 5000-horsepower. The two cabs can be operated together in the same manner as with electric locomotives. It will haul 1000-ton trains such as the Union-Pacific "Challenger" or the Los Angeles Limited over the Los Angeles-Omaha route.

Streamlined, practically smokeless, and provided with equipment for air conditioning, the new locomotive will be modern in every respect. The builders promise speeds of 110 mi. per hr. on level track. Sufficient fuel oil for a long journey will be carried, and the number of stops for fuel will be greatly reduced. Because of this greater availability, an increased mileage per year is expected to develop.

As with the electric locomotive, a finely graduated scheme of control will permit smooth and easy handling, rapid acceleration, and effective braking.

A new, highly efficient type of steam boiler has been built, and tests give ample assurance of power to meet the exacting requirements of the locomotive. The high steam pressure and use of condensers are in line with the latest practice in modern power plant construction.

The boiler will use fuel oil similar to that employed by other locomotives on railroads today, but the method of combustion will be more accurately controlled to obtain the maximum amount of power from a given quantity of fuel. The almost perfect combustion will insure practically smokeless operation.



Electron Tubes

PART IX

THIS BUSINESS of explaining things on paper is not entirely satisfactory. As may have been noticed by those who have had the patience to come this far in this series of articles, we started out in great style—with a picture of a lovely woman, before a microphone to be sure, but still, there she was, to inveigle the unwary into our clutches. Everything was as it should be; the room was quiet, the lights low, there was the girl, and we made her part of our story. We launched into rather a romantic consideration of the wonders of radio and followed this up by a general discussion of things that happen in electric circuits. Next, even though we say it ourselves, there came a rather good sales talk on the glories of the electron tube.

By this time, no doubt, the reader was all primed—expectant, for here, it appeared, was a cross between a love story, a mystery novel and a Buck Rogers strip, indeed, the only one who still had to make his appearance was Philo Vance. This was hot stuff; the reader probably cancelled his subscription to Esquire, True Story and several mystery magazines and extended his subscription to Power Plant Engineering for several years.

And then what happened? Philo Vance never showed up. Jane Froman disappeared and was never heard from again and the first equation appeared in the text. Later a graph came along and before the unsuspecting reader probably realized what had happened he found himself enmeshed in a tangle of curves, wave diagrams and abstract theory which bore little resemblance to the romance he set out to read.

For all this we apologize, and yet, the situation is not entirely of our making. We are still perfectly sincere about the romance of the electron tube and it is still our belief that a child of twelve can be made to understand its operation but this business of explaining it on paper, we repeat, is not all it's "cracked up to be." Despite our best efforts to prevent it, the last few articles have been rather devoid of zest.

Were we explaining these matters in the plant or the laboratory where the action of the tubes could be demonstrated, there would be more diversion. When working with electrical apparatus there is always the chance of somebody making a mistake; connecting a pair of 6 volt filament terminals across a 2000-volt plate transformer for example. Fireworks are always interesting. People drop things. The impact of a $200 electron tube on a concrete floor always has interesting reactions. Meters also burn out and the physiological reaction resulting from the contact of human skin with radio frequency conductors provides elements of interest which extend beyond the purely technical. Its effects upon one's vocabulary must never be discounted. Demonstrations in the laboratory, though at times painful are always intriguing.

But on paper, accidents never happen; everything always works the way it is supposed to. Circuits are usually connected correctly and even if they are not, there is never any "fireworks." Short circuits, as such, have only an academic interest.

With this apology for the absence of the spectacular, let us proceed. If the reader really wishes excitement it is suggested that he buy himself a couple of tubes and meters and try testing out some of the things we

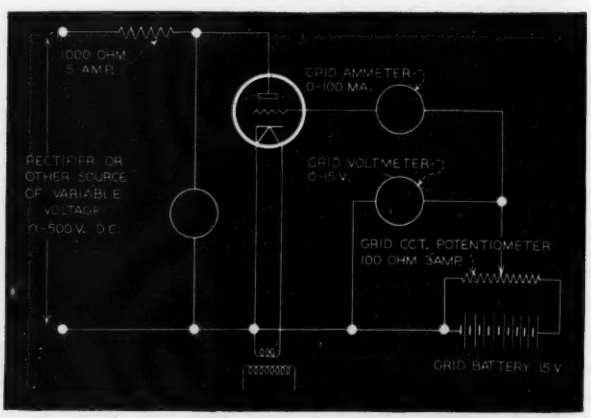

1000 OHM 5 AMP.
GRID AMMETER 0-100 MA.
RECTIFIER OR OTHER SOURCE OF VARIABLE VOLTAGE 0-500 V. D.C.
GRID VOLTMETER 0-15 V.
GRID CCT. POTENTIOMETER 100 OHM 3AMP.
GRID BATTERY 15 V

Fig. 1. Circuit for determining the characteristics of gaseous triodes

—Principles and Applications

Methods of control with gaseous triodes

By A. W. KRAMER

have been talking about. After all, nothing can take the place of actual experience and the results will be well worth the effort.

Suppose, for example, that you had a little Thyratron or grid glow tube set up with a method for varying both the plate and grid potentials on it. A circuit such as shown in Fig. 1 would do nicely and with the exception of the tube it can easily be built from spare parts to be found around the plant. The circuit constants are all given so no difficulty should be encountered in hooking it up.

Even with such a simple circuit as this there is ample opportunity for diversion. In a circuit such as this, and this applies to any of the gas filled tubes, two or three element, the plate voltage should not be applied until the cathode has been allowed to heat up. If this is not done you may, or may not, have to buy a new tube after the first closure of the switch. Assuming that everything is connected properly, however, the

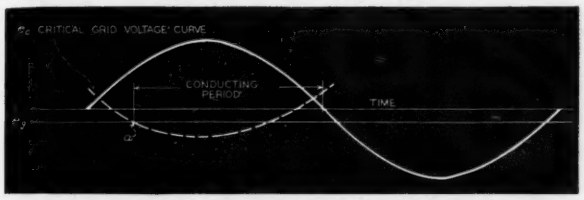


Fig. 2. The dotted curve is known as the critical grid voltage curve. Grid potentials equal to, or more positive than ec render the tube conducting; conversely, grid potentials more negative than ec prevent conduction

grid voltage at which the discharge starts should be measured for various values of plate voltage from 50 to 500 v. Aside from the sudden blue glow in the tube, breakdown will be indicated by the sudden fall of the plate voltage from the applied voltage to a 10 or 15 v. arc drop.

In observing the two voltages in each case it will be found that the grid voltage needed to cause breakdown depends upon the plate voltage. The higher the plate voltage, the lower the grid voltage required. If with 100 v. on the plate a grid voltage of 10 is required to cause breakdown, at 300 v. only 3 volts may be needed, while at 400 v. an actual negative potential may have to be applied to the grid to *prevent* breakdown.

Knowing this relation, the action of the tube under alternating potential instead of direct is more easily understood. With a fixed grid voltage the tube will break down at that instant during the beginning of the positive half cycle when the value of the plate voltage added to the fixed grid voltage already existing is sufficient to ionize the gas in the tube. In other words, with alternating current, the amount of grid voltage needed to initiate the discharge depends upon the instantaneous value of the plate voltage. Thus, as explained in the preceding article, with the application of alternating potential across the cathode and plate, current can be made to flow in the plate circuit during a portion of the positive half cycle, depending upon the value of fixed grid potential, but in no case can the flow period be cut to less than a quarter of a cycle.

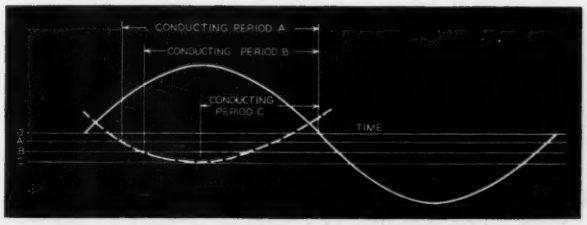
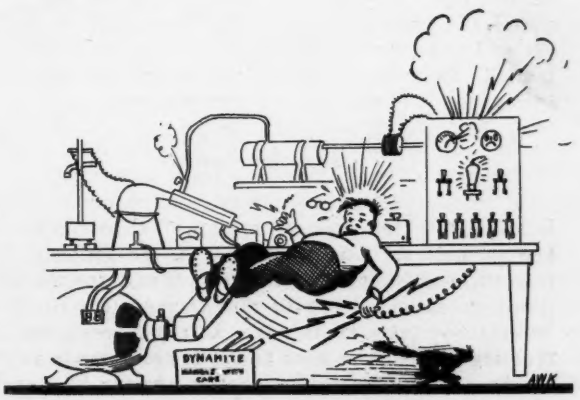


Fig. 3. Diagram showing the manner in which the conducting period can be varied by the application of different grid voltages, A, B, and C

It was also shown, however, that by introducing a "time" element in the application of the grid voltage, with respect to the instantaneous value of the alternating potential across the plate circuit, the flow period could be cut to *less* than a quarter of a cycle.

Amplitude and Phase Shift Control

These two cases imply two general methods of operation; the first an amplitude method and the second a phase shift method. In the amplitude method the voltage applied to the grid is varied until the discharge starts or with a fixed grid voltage the plate voltage is increased until the discharge starts. This has all been fully described.



Demonstrations in the laboratory though at times painful are always intriguing

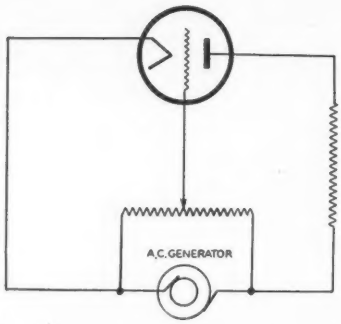


Fig. 4.
In this circuit alternating potential is applied to both grid and plate. The grid and plate voltages are in phase and the tube action is not materially different from that with direct potential

The phase method implies the application of alternating potential to both *grid* and *plate*, consequently, the operation of the tube under such conditions is somewhat different from that when the grid potential is negative.

Before this phase shift method is considered in detail a few words more about the general characteristics of these tubes may not be amiss. If a circuit such as in Fig. 1 is available, so much the better, for then actual readings can be used. However, in the absence of such a circuit you can take our word that what we say is true. If the values of grid voltage at which breakdown occurs under various values of plate voltage are plotted on the same wave diagram with that of the plate potential, a curve of "critical" grid voltages will be obtained as shown in Fig. 2. Such a curve (e_c) is known as a critical grid voltage curve.

Grid potentials equal to, or more positive than e_c will render the tube conducting, and conversely, grid potentials more negative than e_c will prevent conduction. Therefore, if at any time during the cycle the grid becomes more positive than e_c the discharge will start. The grid will then lose control and the tube will remain conducting until the discharge is stopped by the lowered plate voltage at the end of the cycle. If, for example, a constant voltage, represented by e_g in Fig. 2 is applied to the grid, the tube will become conducting at the point a in every positive half cycle and remain conducting until the end of the positive half cycle.

This, it will be obvious, is only another way of explaining the action considered in the preceding article. The fraction of the cycle between the point a and the next voltage zero, that is, the "conduction period," can be controlled by arranging the grid circuit so that the grid voltage curve intersects the critical curve at any desired point between zero and 90 deg. In Fig. 3 is shown the manner in which the conducting period is varied by the application of different grid voltages, A, B and C. In no case, however, can the conducting period be reduced to less than a quarter of a cycle.

Phase Shift Control

If instead of direct potential, alternating potential is applied to the grid by means of a potentiometer arrangement as indicated in Fig. 4, the action of the tube will not differ materially from that described with direct potential. For with this arrangement the grid and plate voltages are *in phase*, both increasing and decreasing at the same time and it is not possible to cut the flow of current to less than a quarter of a cycle. So long as the two voltages, grid and plate, are in phase this limitation in operation exists. This method, i.e., the use of alternating potentials in phase, is still an amplitude method of control.

This is shown graphically in Fig. 5 A, B and C. These diagrams show the effect upon the conduction period of three different values of grid potential. The critical grid voltage curve e_c (shown dotted) is of course fixed by the structure of the tube and is the same in each of the three diagrams. The grid voltage is varied in each of the three cases, so that the curves representing these grid voltages cut the critical grid voltage curve at different points, 1, 2 and 3, as shown. As a consequence, the conduction period is different in each of the three cases.

Suppose now that instead of merely varying the amplitude of the grid voltage wave, it is shifted sideways along the time axis of the diagram as indicated in Fig. 6, A to E. These show five different conditions of phase displacement between the grid voltage and the plate voltage. At A, the two voltages are in phase and under this condition the grid voltage curve cuts the critical grid voltage curve at a point 27 deg. from the beginning of the cycle. At B the plate voltage leads the grid voltage by approximately 18 deg. and as a result of this change in phase relation the conduction period does not begin until 32 deg. after the start of the cycle. The remaining diagrams show further successive phase shifts which will be quite obvious and their effect is to diminish the conduction period in each case.

With this method of control it is evident that the conduction period may be cut to less than a half cycle, indeed by proper selection of tubes and voltages this method permits the discharge to occur at any point in the positive cycle between zero and 180 deg. This method, therefore, provides very much more flexibility than the amplitude method and it is one which is used to a considerable extent in control circuits. It is used extensively in the rectification of alternating current to direct current where the direct current is desired for such applications as motor speed control, battery charging, generator excitation, lighting control, etc.

Method of Obtaining Phase Shift

Electrically, the method of applying the phase shift control is quite simple, the necessary phase displacement being obtained by means of a condenser in com-

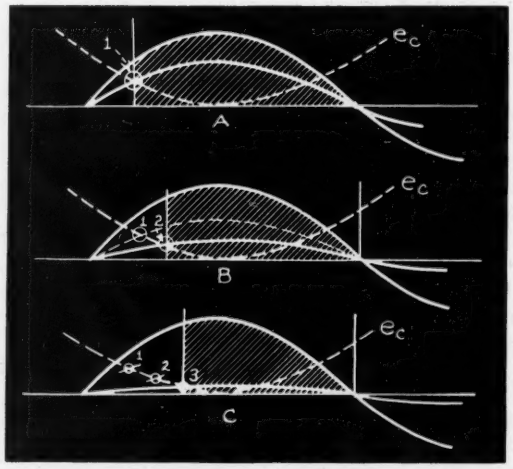


Fig. 5. Diagrams showing the effect of three different grid potentials upon the conduction period

bination with a variable resistor in a circuit such as shown in Fig. 7. This circuit containing only a single tube provides half wave output. The power circuit is from the center tap of the transformer, across the cathode to the plate, through the load and back to the transformer at Y. The control circuit X C R Y requires very little current. It consists of a fixed condenser C and a variable high resistance R bridged across the power transformer winding. The grid of the tube is connected between C and R as shown.

The theory of operation underlying this circuit is quite simple. It is based upon the fact that the current

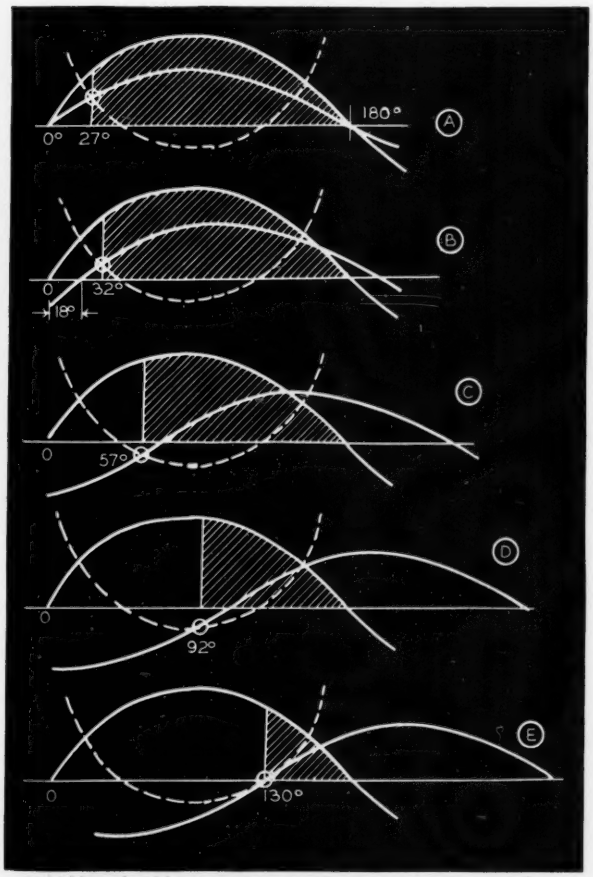


Fig. 6. The effect of five different conditions of phase displacement upon the conduction period

in an alternating current circuit containing only a condenser always leads the impressed electromotive force by 90 degrees while in a circuit containing only resistance, the current is always in phase with the impressed electromotive force. The control circuit X C R Y in Fig. 7, it will be noted, is divided into two parts through the grid cathode circuit of the tube, one side containing only the condenser while the other side contains only the resistor. The currents in these two circuits are displaced in phase.

The action of the circuit is best explained by means of a vector diagram such as that shown in Fig. 8. In this diagram the points X, T, Z, and Y correspond to the points similarly marked in Fig. 7 and the lines between them are the vectors representing the voltages in the circuit between these points. Thus, the line IR represents the voltage drop between the points T and Y in the circuit.

The total voltage drop around the control circuit is, of course, the vector sum of the component voltage drops in different parts of the circuit. The voltage drop across the circuit furthermore must be equal to the impressed voltage. The impressed voltage is that delivered by the transformer, or that acting between X and Y.

Thus the impressed voltage XY is represented by a line connecting the ends of the vectors representing the voltage drop in XT and TY, which are drawn at right angles to each other because they are always 90 degrees out of phase. The vector ZT represents the grid voltage vector.

Knowing that the length of the line XY must remain fixed (because the transformer voltage is constant), it will be obvious that when the length of the line IR is varied, the length of the line IC also will vary, becoming longer as IR becomes shorter. Also, it will be evident that as the ratio between the lengths of IR and IC is changed, the point T (their junction) will trace a semi-circle as shown. Furthermore, since the point T is one end of the vector TZ and since the point Z is fixed, it will be seen that the angular position of TZ with respect to XZ and ZY will be different for each different position of T on the semi-circle. Hence as the value of IR is increased by manipulating the variable resistor R, the phase angle of the grid voltage increases with respect to the plate voltage, and the grid voltage wave is slid to the right as shown in the diagrams in Fig. 6. It is all quite simple and all very much less complicated than it sounds. The vector relations should be clearly understood, however, and that is why they have been discussed in some detail here. If one will only remember that the voltage across the condenser and the resistor are 90 degrees apart, no trouble should be encountered in understanding the action. Combining these voltages *vectorially* gives the total voltage across the transformer.

If R is made large, the phase difference between the grid and plate voltage is great and under these conditions the conducting period per cycle is shortened; when, however, R is made equal to zero, the grid and plate voltages become in phase and the tube will conduct current throughout the whole of the positive half cycle.

By this method of control, therefore, it is possible to control the direct current output of the tube to any desired degree. The circuit shown in Fig. 7, of course, gives only half wave control, but this can easily be expanded into a full wave controller by the use of two tubes as shown in Fig. 10.

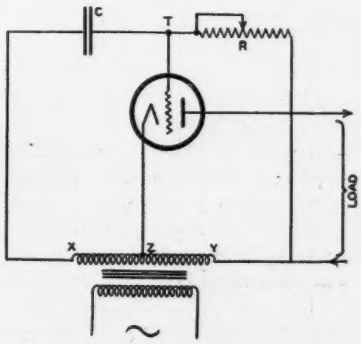
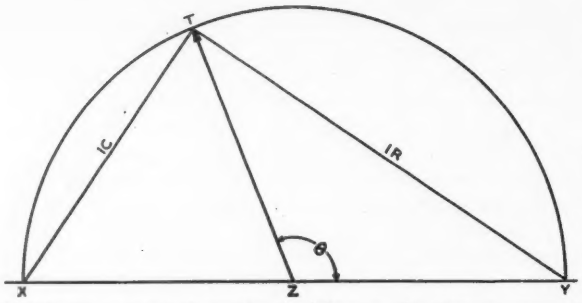


Fig. 7. Circuit for obtaining the phase-shift method of control



NOTE: The points indicated by the letters on this diagram represent the points on the circuit diagram in Fig. 7

Fig. 8. Vector diagram of the voltages in the phase shift control circuit

If desired, the phase shift control circuit may be made up of an inductance and a resistor instead of a condenser and a resistor. In either case the action is the same except that in one case a leading voltage is produced while in the other a lagging voltage results.

Phase Shift Control Has Many Applications

It must be obvious that circuits such as these are very useful and have a variety of applications. The change in resistance through which the control is effected may be accomplished manually, by manipulating a dial or automatically by any varying process or function, or electrically, by means of other tubes. The change in resistance for example may be brought about by means of a photocell through the action of light.

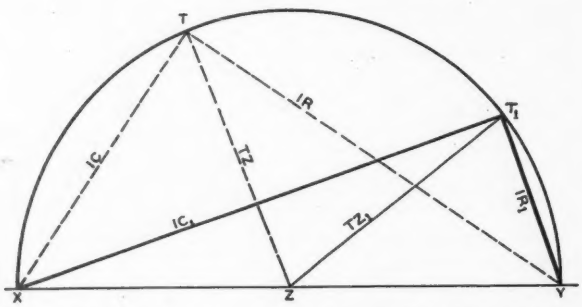


Fig. 9. Showing changed vector relations resulting from a change of resistance

In the case of an alternating current generator, the field current might be supplied through a set of gaseous discharge tubes of this type, and by simply providing an arrangement whereby the resistance is varied by the change in terminal voltage, an electronic voltage regulator results. Such voltage regulators are commercially available and have many advantages over conventional types.

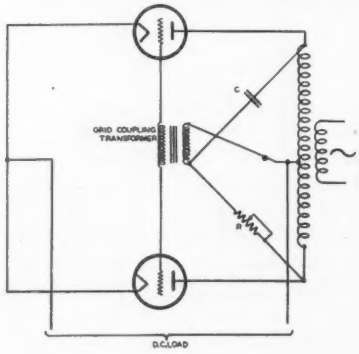


Fig. 10. Circuit giving full wave control

Numerous other applications could be cited but these will be considered later. Here we are still concerned with fundamental principles and we must avoid confusion by not becoming involved in complicated circuits.

As must be obvious from the last four articles, the presence of gas in a thermionic tube entirely alters their characteristics and at the same time provides an entirely new and useful device, suitable for use alone or in combination with high vacuum type tubes. The principal difference between gaseous tubes and high vacuum tubes lies in their current carrying capacities. Whereas the currents in high vacuum tubes are measured in milliamperes, in gaseous tubes they are measured in amperes—even hundreds of amperes. Because of this, gaseous tubes find great application in the industrial field where heavy currents and large quantities of power are involved.

Both the high vacuum type and the gaseous type of tubes are important, however, and one must not form the impression that one type is used only for heavy power purposes and the other type only for light power or control work. In many instances the gaseous tube would be useless without the high vacuum tube, and in many circuits both types will be found, each fulfilling its peculiar and necessary function.

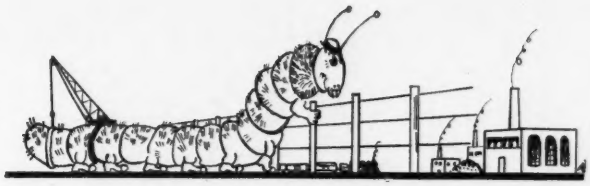
Transformer of Unusual Design is Completed

A transformer just completed at the Pittsfield Works of the General Electric Company, for the Consolidated Gas and Electric Company of Baltimore, Md., has its cooling radiators arranged in three large banks in order to facilitate installation. A motor-driven blower is provided for each bank to increase the cooling effect. These blowers are arranged for manual control, or can be started or stopped automatically as determined by changes in oil temperature.

The transformer is rated 53,330 kv-a. with the forced draft ventilation provided by the blower, and 40,000 kv-a. without the blower in operation. The total weight including oil is 400,000 lb. of which 34,000 lb. is in the copper wire of the windings. It stands 24½ ft. high and covers a floor area of 31½ by 41½ ft. Load ratio control equipment is provided, affording different ratios of transformation and providing great flexibility in the control of the voltage and power factor of the system.

For shipment the three banks of radiators were detached, and the core and coils were shipped in a nitrogen-filled tank car which was built by the General Electric Company especially for protecting large cores and coils in transit.

Study by the National Industrial Conference Board of the sources from which national income is derived has revealed that the part derived from government increased from $6,820,000,000 in 1929 to $9,354,000,000 in 1934, while the amount from private industry dropped from $73,209,000,000 in 1929 to $41,545,000,000 in 1934. The governmental spending, chiefly from borrowed funds, increased 37 per cent while income from productive activity decreased 43 per cent.



CATERPILLAR

Enters Stationary Field

EARLY IN 1925, the Caterpillar Tractor Co. of Peoria, Ill., was formed from a consolidation of The Holt Manufacturing Co. and the C. L. Best Tractor Co., two pioneers in the track type tractor field. The new company soon came to the conclusion that, due to higher efficiency and the ability to use cheap fuel, the Diesel was the logical tractor prime mover. With this in mind an extensive development program was undertaken to adapt the Diesel to the rigid requirements of space, weight and service demanded in the tractor field. So successful was this program that production of the new Diesel was started in 1931 to the practical exclusion of the former gasoline engines. That this step was well justified is proved by the fact that by the summer of 1935 engine No. 10,000 passed down the line. 10,000 engines in four depression years! Within another twelve months the 17,000 mark had been passed.

Three years ago the company entered the industrial field for mobile service such as drag lines, shovels, etc. This line now comprises five sizes, which, as shown by the first part of the accompanying table, range from 33 to 120 br. hp. for continuous service. Three of these units, the D6600, D8800 and D13,000 are used in tractors.

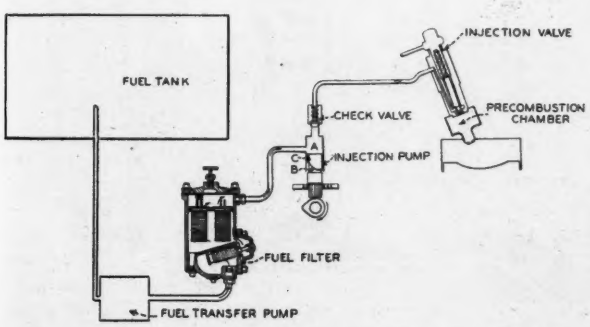


Fig. 1. Diagrammatic arrangement of the Caterpillar fuel and injection system

This year two new engines, as shown by the first and last columns of the table, were added. The larger of these, the D17,000, is the 8-cyl., V-type shown by Fig. 2. These new units greatly broaden the company's field as the D17,000 tops the present D13,000 by 35 hp. and is large enough to drive oil rigs, larger gins, pumps, flour mills, etc. As a generating unit it is offered direct connected to an 80 kw. generator similar to the unit in Fig. 6, one of the smaller 6 cyl. engines. The new D4400 is available with a 20 kw. generator.

Standardization has been developed to a high degree in the entire line and many parts such as cylinder liners, pistons, connecting rods, bearings, timing gear housing, valve mechanism, fuel pumps and injection valves are interchangeable with the older units of the same cylinder size.

With the exception of the arrangement of cylinders in two groups of four set at an angle of 60 deg. as shown by Fig. 2, the D17,000 follows typical Caterpillar design, a four stroke cycle, valve-in-head, water cooled engine with solid injection of fuel into a pre-combustion chamber. Cylinder size is 5¾ by 8 in. and the governor speed is 850 r.p.m. The maximum rating is 160 b.hp., based on an m.e.p. of 90 lb. per sq. in. and the continuous rating is 120 b.hp., corresponding to a m.e.p. of 67 lb. per sq. in. This engine is designed to develop maximum torque at 650 r.p.m. as shown by a typical performance curve, Fig. 5.

Cylinder heads are easy to remove or replace, being cast separately. Cylinder blocks, cast in pairs, may be raised off the crankcase, making unnecessary the removal of connecting rods or crank pin bearings for observation of pistons. Cylinder liners, of heat-treated chrome nickel alloy cast iron, are removable. The grey iron crankcase has four large openings on each side to permit easy access to bearings. The 4-in. drop-forged crank shaft turns through five main bearings having a combined length of 16 in.

The fuel injection system is shown diagrammatically

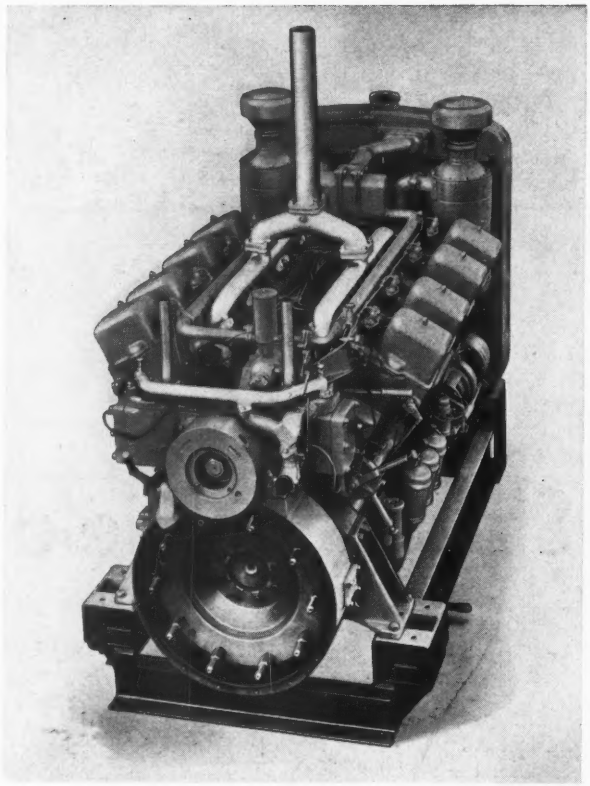


Fig. 2. The Model D 17,000 engine, a V-8 with 5¾ by 8 in. cylinders, has a maximum output of 160 b.hp. at 850 r.p.m. The gasoline starting engine is in the foreground, the fuel pump in the V between the cylinders. Air and oil filters, manifolds and water thermostat are supplied for each bank

in Fig. 1. A single row of eight individual fuel pumps is conveniently located between the cylinder banks and all fuel lines to injectors are the same length. The fuel transfer pump, driven on this engine from the end of the water pump and visible in Fig. 2, is of the gear type and is supplied with fuel by gravity from the fuel tank. This oil is delivered through a two stage, edge type filter to the injection pumps at low pressure. Action of the injection pump is apparent from the sketch, Fig. 1. The plunger, lapped in the barrel with close clearance so as to eliminate packing, has a scroll cut as shown, with a mechanical passage C connecting the top space A and the bottom space B so that both of these are of necessity under the same pressure.

As shown, the plunger is in the extreme down position with the pump barrel and fuel lines full of oil. As the cam revolves the plunger is forced sharply upward, and, when the port from the filter is completely covered, injection begins. This happens at the same point, regardless of load. As the plunger continues its upward stroke injection continues until the lower edge or scroll uncovers the port and relieves the injection pressure through the port. The position of the scroll is determined by a rack under control of a flyball governor. As the plunger returns the cylinder is filled with fuel through the fuel line. Injection takes place through a single hole nozzle into a precombustion chamber as shown by Fig. 1. Fuel and lubricating oil filters, air cleaners, manifolding, cooling and thermostatic control are individually supplied for each cylinder bank.

Lubrication is of the forced feed type. The oil pump, shown by both Figs. 3 and 4, is driven from the camshaft, and combines both scavenging and pumping units. The scavenging unit draws oil from the oil pan as shown and delivers it through a screen to the sump when it is picked up and delivered, through another screen, to all parts of the engine at approximately 30 lb. pressure. The camshaft is forged with the gear oil pump drive gear and cams integral.

Air for combustion is taken through two Donaldson air cleaners, one for each bank of cylinders. These cleaners are standard equipment on all Caterpillar engines and are particularly important in tractor and industrial service in which the machine often operates under severe dust conditions. Larger particles such as

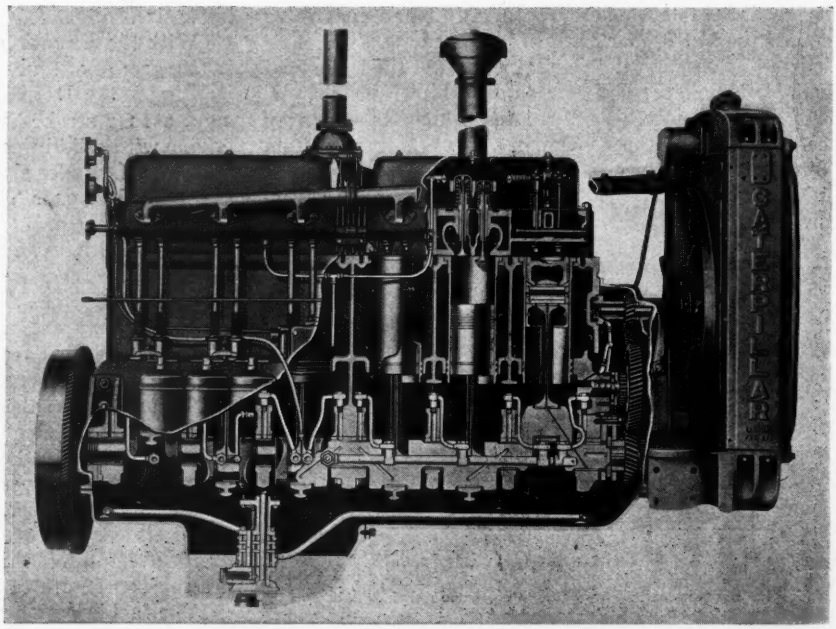


Fig. 3. Longitudinal section of the D 13,000 engine which differs from the D 17,000 only in the arrangement of cylinders and lends itself better to sectionalization. The lubricating oil pump and the fuel pump (which in the D 17,000 is located in the V between the cylinders) are both driven from the cam shaft which in turn is gear driven from the front of the engine as shown

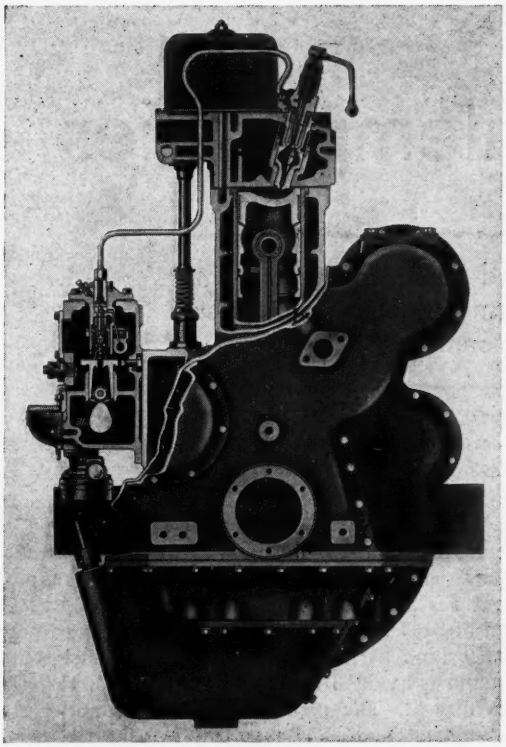


Fig. 4. Typical cross section of Caterpillar Diesel

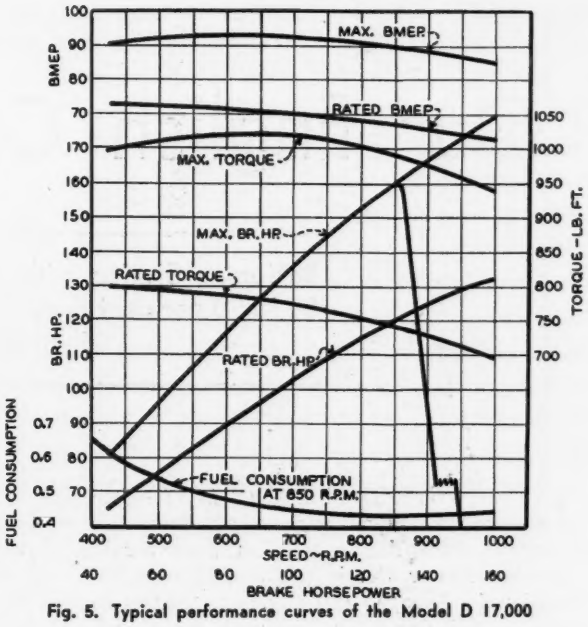


Fig. 5. Typical performance curves of the Model D 17,000

leaves, as well as snow and rain, are excluded by the hood.

Each engine is complete with its own cooling system, radiator, fan and piping with the water temperature under control of a thermostat. Two centrifugal pumps, one on each cylinder bank, are used on the D17,000, to provide cooling water circulation. They are gear driven from the shaft and one of them visible back of the oil filters in Fig. 2. The thermostats allow water circulation through the engine block only during starting and until the water temperature increases to a normal temperature of about 175 deg. F. During the starting period warm jacket water from the starting engine is circulated around the Diesel cylinders.

This starting engine, a 28-hp., 2-cylinder gasoline type, is mounted at the rear of the engine directly over the flywheel housing, and requires no additional space. It is of 4 cycle, horizontal opposed piston design having a bore and stroke of 3¾ by 4 in. and a governed speed of 3000 r.p.m.

The D17,000, fan-to-flywheel, weighs 7150 lb., and equipped as a power unit with radiator, base and accessories, 11,500 lb. Standard industrial power units consist of the engine mounted on a steel channel base, fuel tank, pumps, fan and radiator. They may be supplied for direct connection as shown by Fig. 6 or with a clutch, extended shaft and pillow blocks for pulleys.

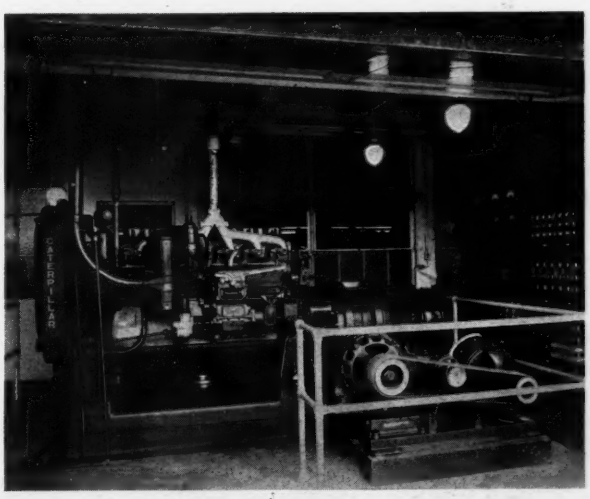


Fig. 6. A 6 cylinder engine in stationary service driving an electric generator

Construction and Performance Data on Various Engines

MODEL	D4400	D6600	D8800	D13000	D17000
Maximum, B.hp.	44	60	80	125	160
Continuous, B.hp.	33	45	60	95	120
Governed speed, r.p.m.	1400	850	850	850	850
Torque at maximum hp., lb. ft.	165	371	496	772	989
Maximum torque, lb. ft.	180	396	513	824	1020
Speed at maximum torque, r.p.m.	900	650	700	650	650
Number of cylinders	4	3	4	6	8
Bore and stroke, in.	4¼x5½	5¾x8	5¾x8	5¾x8	5¾x8
Piston displacement, cu. in.	312	623	831	1246	1662
Piston speed, f.p.m.	1283	1133	1133	1133	1133
Number of main bearings	5	4	5	7	5
Diameter of main bearings, in.	3	3½	3½	3¾	4
Total bearing area, sq. in.	89.5	108	156	214	194
Overall dimensions of power unit:					
Length	8'-6½"	8'-10¼"	9'-9¾"	12'-11"	12'-8"
Height	4'-1"	5'-1⅝"	5'-1⅞"	5'-6⅞"	6'-3"
Width	31¾"	3'-4⅝"	3'-4⅝"	4'-5⅞"	4'-2"
Shipping weight of power unit, lb.	3740	5690	6310	8430	11500
Net weight of engine, lb.	1975	3260	4090	5035	7600

Our English Contemporaries—

Battersea Station with a load factor ranging from 80 to 90 per cent shows a thermal efficiency of better than 29 per cent.

DUE TO ITS HIGH EFFICIENCY, large size and extensive investigations of dust and sulphur removal from flue gases, Battersea Station of the London Power Co. is probably the most talked of station in Europe. Initially, six, 312,000 lb. per hr., 615 lb., 875 deg. F. boilers with superheaters, economizers and air heaters were installed together with two 80,000 kv-a., 11,000 v., 3 ph., 50 cycle, 1500 r.p.m. turbo-generators set over 60,000 sq. ft. condensers. An extension consists of three 375,000 lb. per hr. boilers and one 105,000 kw. turbine set over twin 60,000 sq. ft. condensers.

The feedheating cycle, shown diagrammatically by Fig. 2, utilizes five extraction heaters, a gland cooler, drain cooler and steam jet condensers. Three evaporators are installed, any two having sufficient capacity to take care of the normal 3 per cent makeup. Temperatures shown in Fig. 2 are for the most efficient load of 84,000 kw. and with the evaporators in service.

Flashing of the drains to the main fuel condenser vacuum is avoided by the construction of the deaerating hotwell. The point of entrance is under a small static head and as a result it is said the combined condensate leaving the hotwell may be raised as much as 8 deg. above saturation temperature of the main condenser vacuum.

The hotwell pump delivers condensate through the steam jet condensers, drain cooler, gland heater and two low pressure extraction heaters to the suction of the boiler feed pumps. Irregularities between the hotwell delivery and boiler feed demand are taken care of by surge and storage tanks. The storage tanks, 82 ft. above the basement floor, float on the suction to the second low pressure heater as shown. This tank, or tanks, as there are three, have float controlled overflows to the surge tank. A slight circulation from the surge tank back to the main condenser is maintained through a manually controlled line so as to prevent aeration of the condensate in storage. If the storage tank empties, the surge tanks discharge direct to the boiler feed suction through a non-return valve normally held shut by the excess pressure from the higher storage tank.

On the two original units hotwell level was maintained by a float controlled valve admitting water from the hotwell pump discharge direct to the surge tanks. These valves have been modified so as to operate as before when the new unit is not operating or, when the new unit is operating they maintain constant level and at the same time control the hotwell pump discharge to agree with the boiler suction as determined by the water level in the storage tanks.

Boiler feed pumps discharge through three high

Fig. 1. The boiler aisle in Battersea Station. The main instrument panel is in the control room on the balcony at the far end of the aisle. Each boiler has an individual control panel, four of the six being shown in the photograph. The six boiler load indicators under the control balcony are 12 ft. long and serve both as flow gages and as part of the signalling system. (Photo courtesy Electroflo Meters Co., Ltd.)

pressure extraction heaters to the boilers. Drains from these heaters are cascaded to the next lower heater through traps and flash boxes as shown to a heater drain pump which pumps to the suction of the boiler feed pump. The evaporators operate between the third and second extraction point, drains being pumped with the high pressure heater drain and the vapor, after passing over an evaporator feed heater, being condensed in the second low pressure heater.

Gland steam is condensed in a small heater between the two low pressure extraction points and is drained, through a tank to a flash tank where it joins the low pressure heater drain to pass through a drain cooler to the condenser hotwell. On the basis of 60,000 g.p.m. (Imperial) of 55 deg. F. circulating water, the condenser was designed to give a vacuum of 29.1 in. at the most economical load of 84,000 kw.

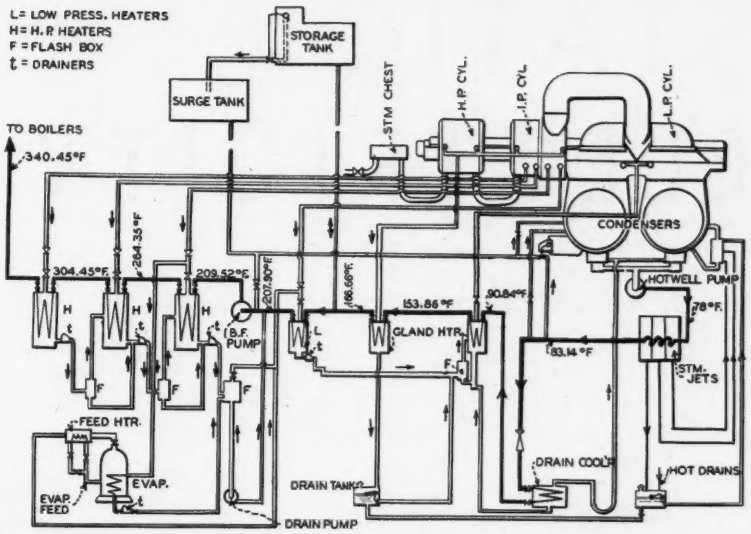


Fig. 2. Diagrammatic representation of the feed heating cycle of the station

Control equipment and instrumentation are unusually complete. Adjacent to each boiler there is a desk type panel, fitted with instruments and remote control gear for the forced and induced draft fans, stoker motors, and superheated steam valves, four induced and four forced draft fans are provided for each boiler. Current supplied to the fan and stoker motors is indicated on edgewise ammeters. The panel also carries superheated and saturated steam pressure indicators and indicators for showing individually the feed-water pressure, steam flow or boiler load, CO_2 percentage, steam flow-air flow ratio, smoke density, hot air temperature, and flue gas temperature.

Central Control Room

From the control room overlooking the boiler aisle, instructions are issued to the boiler house staff by means of an ingenious signalling system, incorporating the large illuminated boiler load demand and compliance indicator shown in the headpiece. The control room contains indicating and recording instruments covering every phase of operation and includes a master megawatt indicator giving the total electrical load on the station.

Each panel provided for the individual boilers carries a steam flow recorder and integrator, showing the total evaporation of the boiler, a CO_2 recorder giving the CO_2 percentage in the flue gas at the air heater exit, and a 20-point indicating pyrometer for checking the steam, feedwater, air and flue gas temperatures at all essential points. The more important temperatures, e.g., steam, final flue gas and hot air to grates, are recorded continuously on continuous strip chart type pyrometers. The steam and feedwater pressures are continuously recorded on a similar instrument, operated by electrical distance transmitters.

For each of the generating sets installed in the station there is a turbine gage board, a ventilating system control panel and two telegraph panels. The ventilating panel carries a thermo-electric temperature indicator, push button switches controlling the ventilating fan, ammeters for showing the current consumed by the fan motors, and a system of levers and hand wheels for regulating the fan dampers.

The indirectly illuminated instruments comprise a steam flow recorder and integrator for recording and integrating the flow of steam into the turbine, a condensate recorder and integrator, surge water flow recorders and integrators, sixteen pressure gages for steam and oil pressures, eight dial thermometers for air and oil temperatures, a 62-point electrical resistance type temperature indicator, a four-point electrical resistance type temperature recorder, a synchroscope, a wattmeter, a vacuum gage, alarm lamps, etc.

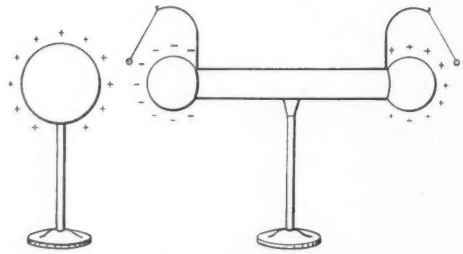
Meters

Steam is delivered to each turbine through four 9-in. pipes and the total flow is measured on a single meter by a current balance. As water may flow either to or from the surge tank and the rate of flow may vary over an extremely wide range and as changes in the direction of flow may take place suddenly at any moment, the problem of metering the surge water presented some difficulty. An orifice plate in a specially designed steel carrier ring is inserted in the surge main, and the design is such that the flow in either direction may be measured by four meter bodies, two for each direction of flow.

Each meter body is connected to a separate set of reading instruments, comprising a five-figure cyclometer type direct-reading integrator and a recording pen. The four records (together with a fifth record of condensate flow) are made on a strip chart recorder, utilizing a 12 in. wide chart with separate zones for "Surge Up," "Surge Down," and "Condensate." The appropriate set of reading instruments is in circuit at each instant, the other instrments being rendered inoperative by a system of relays. In this manner accurate measurement is possible from a maximum of 700,000 lb. per hr. down to a minimum of 17,500 lb.

STATIC ELECTRICITY

By J. M. MYERS



A brief discussion of the hazards created in the generation of static electricity and methods commonly used in overcoming these hazards.

THE ACTION OF static electricity, though often interesting, nevertheless constitutes a serious fire hazard in many industries and its presence often is also a nuisance, hence methods have been evolved for eliminating it or at least guarding against it.

Low voltage static sparks are extremely common and the only reason they do not cause more trouble is that the energy involved in such discharges is too low to cause sufficient heat to fire explosive mixtures of gases which may be present. For example, if a small amount of dust is present in the air, the wind blowing across an insulated metal plate on a dry day will generate a charge on the plate that can be measured by suitable instruments but the potential is quite low and conditions usually are not favorable to cause an explosion, in case the charge should dissipate itself in sparking from the metal plate to ground or some other conducting object. The seriousness of static is primarily a question of quantity, time and heat and the presence of something exceedingly sensitive to heat such as an inflammable gas. Some sparks will ignite an inflammable vapor while others will not, depending upon the amount of heat generated.

The presence of static is most conveniently determined by means of a static voltmeter which indicates not only the presence but also the potential of the charge. The presence of a charge may also be noted with an electroscope or even by means of a cotton thread held near the object to be tested. If static is present, the fibers of the thread will stand out, giving it a bristling appearance.

In industrial plants the two most common methods of eliminating static are, first, grounding, and second, maintaining a high humidity. For best results the humidity should be between 50 and 60 per cent of saturation.

Thus, where it is impossible to prevent the occurrence of static sparks and where the trouble cannot conveniently be eliminated by other methods, a properly designed ventilating system involving means for controlling humidity is perhaps the safest protection against accident due to explosive vapors or dust which may be present.

Discharges of static from machinery used in manufacturing processes are always a source of annoyance to persons operating the equipment and sometimes a source of considerable danger. The danger from shock is perhaps the least serious although sometimes these can be quite violent. More serious is the danger of having the operator's hair or clothing attracted by the charges and drawn into moving machines.

Static charges on conducting material are easily removed by grounding such conductors at a single point but with non conductors, such as leather or rubber belting or paper, removal is more difficult since the charges will not flow readily to ground even though the material may be running over grounded metal pulleys. To avoid difficulties in such cases the charge should be removed from the belt at approximately the point where it is generated, that is near the point where the belt leaves the two pulleys. This is usually done by having a grounded wire comb rubbing on the belt near the point where the belt leaves the pulley. Static is usually more noticeable on belt driven machines mounted on wooden or insulated floors than on iron or steel equipment which is usually grounded. Static is more noticeable on leather belting than on rubber belting because rubber belts have a more uni-

form surface causing less friction in the air and pulleys. Also most rubber belts have the advantage of containing cotton fabric which acquires a positive charge while rubber charges negatively. The two charges, therefore, tend to neutralize each other. On large belts carrying grain, static potentials as high as 45,000 v. have frequently been found.

From accident reports it is often brought out that serious fires on trucks hauling gasoline, kerosene and oil have been traced to static discharges caused by the vehicles not being properly grounded. The reason for the generation of static charges in such cases is not always clear but certain tests made by the U. S. Bureau of Standards throw some light on the subject. When water falls at a velocity greater than 25 ft. per second the drops break into a spray, the smaller particles of which carry static charges resulting from the separation. This principle probable is inherent in the formation of static in thunder clouds. Gasoline, having a lower surface tension than water, breaks into a spray when thrown through the air by the motion of a car moving over a road, thus building up static charges in the gasoline which, being a good insulator, may accumulate into a charge of high potential depending of course upon the quantity of gasoline present and the amount of disturbance. Due to the small quantity carried in passenger cars large charges are seldom built up from this cause. In this case, however, air friction against the body of the car and tire friction on the road sometimes causes dangerous charges to accumulate. For example, a sedan with disc wheels and balloon tires when driven over a concrete road at 12 mi. per hr. was found to have accumulated a charge of 3000 v. A car charged in this manner is usually discharged by the first person touching it. This might be at the filling station when the attendant removes the gas tank caps or if the concrete is very dry, the discharge might not take place until the nozzle of the filling hose almost touches the tank opening. The spark occurs as the hose approaches the mouth of the gas tank. Static may also be produced by the gasoline flowing through the hose, whether it be grounded or ungrounded, also by the breaking up of the gasoline into a fine spray after it leaves the hose nozzle and before it reaches the bottom of the tank. In the case of some fires on record which were of static origin, they did not occur until some gasoline had entered the tank. For these reasons tank trucks should be continuously grounded by means of a trailing chain which rests on the ground at all times and when loading and unloading, a more stable ground should be attached to the truck chassis.

In filling tank cars with inflammable solvents, they should be protected by a permanent bond between the filling lines and the rails.

Structures such as towers, metallic tanks and steel buildings should all be well grounded. Tanks should have a grounded conductor attached to each of the pipe lines connecting with it and also with the tank itself. In filling drums or other containers extra care should be taken to see that the drum is well grounded and electrically connected or bonded to the pipe or filling nozzle. Dangerous fires have been caused by failure to observe this rule of grounding.

Aeroplane manufacturers overcome the hazard of static by coating the fabric with a paint that takes on opposite charge from the fabric itself.

Paint spraying also generates considerable static. Tests reveal charges as high as 10,000 v. caused by spraying ungrounded metal objects of large size. These tests were conducted after an empty tank which had contained benzol vapors mysteriously blew up while being painted.

Static sparks may usually be drawn from long transmission lines after the power current has been cut off. These charges are caused by wind friction, static induction as well as the inherent capacity of the line itself. In this case the hazard is usually only that of electric shock but since the potential involved may be extremely high, caution should always be observed in working on such lines by first grounding them securely by means of a flexible conductor.

The Parable of the Dangerous Cliff

ANONYMOUS VERSE presented at the Annual Meeting of the St. Louis Safety Council by Lloyd Blanchard, National Safety Council field representative.

'Twas a dangerous cliff, as they freely confessed,
Though to walk near its crest was so pleasant;
But over its terrible edge there had slipped
A duke and full many a peasant.
The people said something would have to be done,
But their projects did not at all tally.
Some said—"Put a fence round the edge of the cliff";
Some—"An ambulance down in the valley".

The lament of the crowd was profound and was loud,
As their hearts overflowed with their pity;
But the cry for the ambulance carried the day
As it spread thru the neighboring city.
A collection was made to accumulate aid,
And the dwellers in highway and alley
Gave dollars or cents—not to furnish a fence,
But "an ambulance down in the valley".

"For the cliff is all right if you're careful," they said;
"And if folks ever slip and are dropping,
It isn't the slipping that hurts them so much
As the shock down below when they're stopping".
So for years (we have heard), as these mishaps occurred
Quick forth would the rescuers sally,
To pick up the victims who fell from the cliff,
With the ambulance down in the valley.

Said one, in his plea, "It's a marvel to me
That you'd give so much greater attention
To repairing results than to curing the cause;
You had much better aim at prevention.
For the mischief of course should be stopped at its source,
Come neighbors and friends, let us rally.
It is far better sense to rely on a fence
Than an ambulance down in the valley".

"He is wrong in his head" the majority said;
"He would end all our earnest endeavor.
He's a man who would shirk this responsible work,
But we will support it forever.
Aren't we picking up all, just as fast as they fall,
And giving them care liberally?
A superfluous fence is of no consequence,
If the ambulance works in the valley".

The story looks queer as we've written it here,
But things oft occur that are stranger,
More humane, we assert, than to succor the hurt,
Is the plan of removing the danger.
The very best plan is to safeguard a man,
And attend to the thing rationally;
To build up a fence and try to dispense
With the ambulance down in the valley.

The Constructor

Capacity Calculations for Refrigeration Coolers and Condensers

General equations and data for capacity calculations with results to be expected from proper control.

By W. R. Kitzmiller

IN A REFRIGERATING SYSTEM employing a compressor the load in tons of refrigeration is evident from the pressures under which it operates.* Where several compressors are used having more capacity than required by the system it is possible to determine the cooling from the products being cooled plus insulation losses. As a general rule the ice plant is the only system producing refrigeration at a constant rate. The cold storages, meat packers, ice cream and processing plants have quite a variable load and, therefore, must arrive at some average with sufficient capacity to handle the peak load.

There are many different cooling and freezing systems employed today but in general the load requirements are somewhat the same. Table I gives the approximate temperature, capacity and insulation generally used for various types of storages:

Table I. Approximate requirements in tons of refrigeration for various storages

Size in Cu. Ft.	A 0 Deg. F. 6" Cork	B 32 Deg. F. 4" Cork	C 35 Deg. F. 4" Cork	D 40 Deg. F. 4" Cork
		Tons Refrigeration		
1,000	2.5	.5	.3	.5
2,000	5.5	.8	.5	.8
3,000	8.5	1.0	.7	1.0
5,000	13.5	1.5	.9	1.6
7,500	15.0	2.0	1.2	2.3
10,000	27.0	2.5	1.8	3.0
15,000	...	3.5	2.5	...
20,000	...	4.4	3.0	...

A—Freezers for ice cream, poultry, meat, and fish.
B—Storages for eggs, apples, poultry, game, and dairy products.
C—Storages for general produce, vegetables, furs, etc.
D—Storages for citrus fruits, precooled meats, etc. (Fish and milk storages are approximately twice this value.) (Freezer values for fish are covered in Col. A.)

Where ice cream freezers are used or definite quantities of food are frozen the actual loads can be determined. Regardless of whether the load was found for a new system, an existing system, or from the pressures on which the compressor is operating, a definite suction pressure must be decided upon. The temperature corresponding to this pressure will determine the amount of surface in Eq. 1. In an existing plant where the difference between the suction gas and room temperature is too large, this same formula can be used to determine the proper amount of surface to be used. An increased amount of surface will reduce operating expenses, increase humidity and reduce frost accumulation in the high temperature rooms.

*Methods of calculating the capacity from compressor and operating data were discussed in an article by the same author on page 681 of the December 1935 issue.

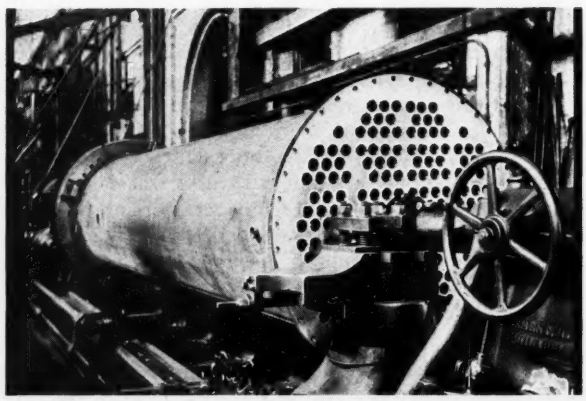


Fig. 1. A multipass cooler gives high rates of heat transfer. This photograph of the machining operation shows the tube holes, ribs for the passes and bolt holes. Condenser and cooler designs are similar

$$\frac{TR \times 12{,}000}{MTD \times U} = \text{Sq. Ft. cooling surface.} \qquad \text{Eq. 1.}$$

TR = refrigerating load in tons of refrigeration.
MTD = temperature difference between room and refrigerant. Where brine is used as refrigerant find average brine temperature.
U = transfer in B.t.u. per sq. ft. per degree M.T.D. per hour. This will vary between 1½ and 2½ depending on service. For freezer and room coils collecting large amounts of frost, the lower value can be used. The higher value can be used for good natural air circulation, higher temperatures and small accumulations of frost.

This formula can be used to find the cooling surface in brine coolers, air conditioning units, or any cooler involving the transfer of heat to the refrigerant. It is only necessary to use the correct value for U which varies for the different types of coolers. Flooded control of cooler surface is generally accepted

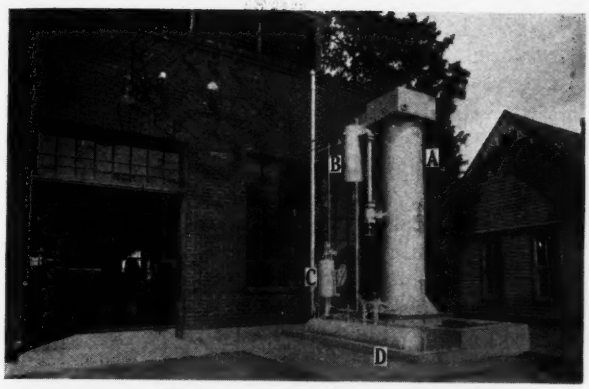


Fig. 2. A vertical shell and tube condenser (A) with oil separator (B), and purger (C) and ammonia receiver (D)

as the best means of securing the highest heat transfer. This is generally accomplished by using float controls or electric valves. Some of the values to be expected for U in different types of coolers are:

1. Forced air over coils, 3 to 6.
2. Forced air over coils with brine spraying on coils, 10 to 15. With water spray instead of brine as used for some types of air this value may reach 40. This depends a great deal on evaporator design, amount of spray, and quantity of air.
3. Closed brine coolers, commonly called multipass, for temperatures around 15 to 20 deg., 50 to 100. For low brine temperature, 0 to —10 deg., 30 to 60.
4. The multipass cooling water cooler will run as high as 200 but this depends to a great extent on design.

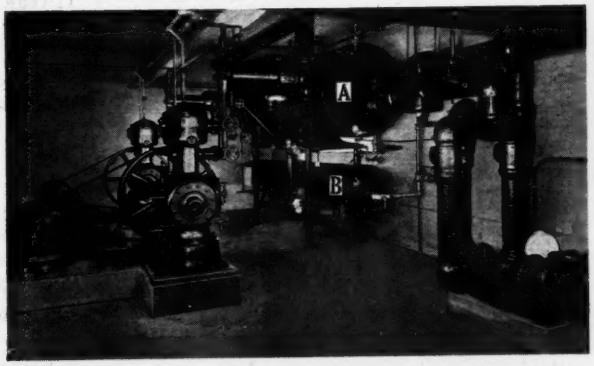


Fig. 3. A multipass condenser (B) and a multipass brine cooler (A) installed in a hospital plant

The lower values are always recommended for an average installation with low velocities and improper flooding.

The condenser is the only remaining equipment of primary importance requiring checking for proper operating results. The most important things involving the condenser are the load and design according to the water conditions. No control is necessary except in automatic plants and hookup will depend on design.

Exceedingly large pressure drops in the piping should be avoided since the compressor constantly requires additional power. In an existing plant this difficulty can usually be overcome inexpensively in a short time. The velocity in the discharge line can be designed for 6000 and in the suction line from the evaporator for 4000 ft. per min.; the latter is usually the more important.

Formulae used to determine the surface and quantity of water for ammonia condensers are given by Eqs. 2 and 4.

$$\text{Square feet of condenser surface} = \frac{TR \times K \times 60}{MTD \times U} \qquad \text{Eq. 2.}$$

where
TR = compressor load, tons of refrigeration.
MTD = mean temperature difference between ammonia and water, in deg. F. This is calculated from

$$MTD = t - \left(\frac{t_1 + t_2}{2} \right) \qquad \text{Eq. 3.}$$

t = ammonia saturated temperature corresponding to condensing pressure
t_1 = temperature of water in
t_2 = temperature of water out
U = Transfer B.t.u. per sq. ft. per degree M.T.D. per hour
K = B.t.u. per minute per ton of refrigeration
The water requirement

$$G.P.M. = \frac{TR \times K}{R \times 8.33}$$

which may be written $R = \dfrac{TR \times K}{G.P.M. \times 8.33}$ Eq. 4.

where
G.P.M. = gallons water circulated per minute
R = temperature range between water in and out

It will be noted the quantity of water can be calculated, or, with the quantity known, the range can

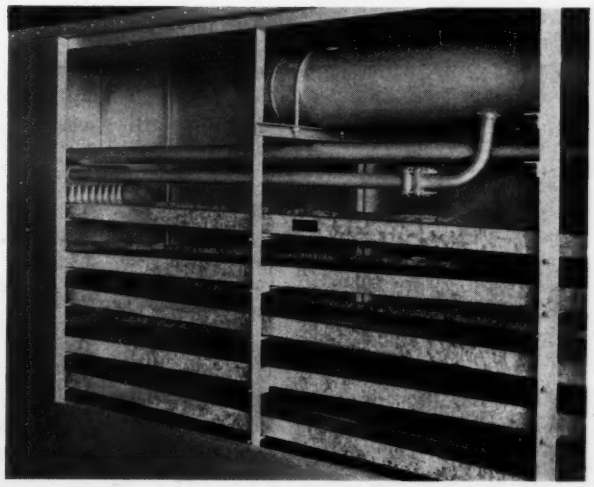


Fig. 4. An open type water cooler in which the water flows over the pipes. The cooling coils are flooded and the large tank at the top is a float controlled accumulator

be found. The range is required in determining the M.T.D. for the surface formula. The B.t.u. per ton to be removed in the condenser is more than the standard ton by an amount equivalent to the heat of compression. This amount can be found from the Mollier diagram and will check out approximately as follows:

Due to the work of the compressor more than the standard ton of 200 B.t.u. per min. must be removed from the condenser

Suction Pres. #/Sq. In. Ga.	Condensing Pressure Pounds Per Square Inch Gauge												
	105	115	125	135	145	155	165	175	185	195	205	215	225
	B.t.u. to Be Removed Per Minute Per Ton Refrigeration												
5	247	250	253	255	258	260	262	265	267	269	272	274	276
10	240	243	246	248	250	253	255	257	259	261	264	266	268
15	235	237	240	242	244	247	249	251	253	255	258	260	262
20	230	232	235	237	239	241	243	245	247	249	252	254	256
25	226	228	231	233	235	237	239	241	243	245	247	249	251
30	224	226	228	230	232	234	236	238	240	242	244	246	248
35	222	224	226	228	230	232	234	236	238	239	241	243	245
40	221	223	224	226	228	230	232	234	236	237	239	241	242

Heat transfer in condensers, as in coolers depends on design and operating conditions. The multipass shell and tube condenser similar in design to cooler in Fig. 1 develops a heat transfer, U, from 100 to 200. The vertical condenser offers an efficient condenser under many conditions. The water flows through the tubes by gravity and the capacity depends on the flow per tube. The heat transfer for the vertical condenser is generally taken as 150 for average flow through the tubes. For large water quantities per tube U will reach that of the multipass type. Figure 2 illustrates a typical vertical shell and tube condenser.

In arriving at M.T.D. some prefer to use the logarithmic mean temperature difference as calculated from Eq. 5 rather than the simpler arithmetic mean temperature difference as calculated from Eq. 3.

$$\text{MTD} = \left(t_2 - t_1 \right) \div \log_e \left(\frac{t - t_1}{t - t_2} \right) \qquad \text{Eq. 5.}$$

t = saturated temperature of ammonia at condensing pressure
t_1 = initial water temperature
t_2 = final water temperature

This is unnecessary in average calculations since the difference between this logarithmic method and the arithmetical method is but slight except as the difference between the water and ammonia temperatures becomes large. The use of superheat removers ahead of condensers increases their efficiency. In reality this is more condenser surface although it has the advantage of removing oil and transferring heat from the hottest ammonia. Considerable work is accomplished in this vessel since the M.T.D. between water and ammonia is large and a large quantity of water already passed through the condenser can be used.

Non-condensable gases in the condenser should be removed by purgers as an increase in condensing pressure due to non-condensable gases requires considerable more power. Where purgers are not in service hand purging is of utmost importance since a small loss of gas means very little compared to the actual power saving secured.

Selection of heat exchangers is important and should never be overrated since they finally resolve into efficient operation or trouble. Many handbooks give values as applied to particular designs. These cases are safe since they are test data but the design and hookup must be strictly adhered to. In the case of condensers the loss in heat transfer due to scaling and corrosion are often neglected by selecting the heat transfer for clean tubes. Therefore, after several months' operation in the heat of summer disappointing results are secured. The same thing is true in selecting coolers, so a liberal safety factor is required unless you have access to test data.

In Fig. 3 is shown the typical installation of multipass cooler and condenser. These vessels are easily applied to most any location in existing plants. In addition to high heat transfer they generally offer an economical installation. Figure 4 illustrates the ZigZag Cooler used for brine or water cooling of the open type. This cooler cannot freeze up and cause any damage since the liquid flows in the pan around the pipe. With water quantities of 6 to 9 g.p.m. per pipe width or twice this value for double rows the heat transfer approaches that of the multipan type.

Grand Coulee Progresses

THE FIRST MILLION cubic yards of concrete has been placed in Grand Coulee Dam, under construction on the Columbia River in eastern Washington, the Bureau of Reclamation reported on Aug. 15th to Secretary of the Interior Harold L. Ickes.

The one millionth yard was placed without ceremony last night. Pouring of concrete began December 6, and to reach the millionth yard today an average of nearly 4,000 cu. yd. a day has been maintained. The present contract calls for placing a total of about 3,200,000 additional cubic yards of concrete.

The record pour made in one day to date has been more than 7,100 cu. yd. of concrete. Only one mixing plant, that on the west side of the river, has been in operation up to this time. However, the east mix plant is about ready to begin its daily stint. The river has receded and the east excavation has been pumped out. The bedrock in the eastern excavation is being cleaned for the pouring of the first concrete in that area. Once the second mixing plant goes into operation, record pours can be expected immediately.

Frank A. Banks, Construction Engineer of the Bureau of Reclamation in charge at the dam, reported that work has begun on construction of two cross channel cofferdams, which will require a total of 8,000,000 board feet of lumber, preparatory to diverting the flow of the Columbia River beginning about October 1.

Forcing this great river from its ancient channel is considered the most difficult engineering feat in connection with construction of Grand Coulee Dam. At present work is progressing on either side of the main channel and the river is kept out of the excavations by cofferdams, temporary structures which confine to a smaller channel but otherwise do not disturb the river. In order that bedrock may be uncovered in midstream and the central section of the dam poured, the river must be diverted. It will be made to shift westward about two hundred yards and flow through an opening which is being left in the western side of the dam, that part which now is being poured. The stream will be raised about three feet in the diversion process.

The cofferdams which will close off the central section will be built up from either end by fastening in place sections which are manufactured ashore. The most difficult task will be placing the last section of the first of these cofferdams, the section which pinches off the swift current. This section will be slightly wedged in shape and will form the keystone of the whole structure. The fact that bottom of the river is a slippery clay will complicate the task.

Other work in progress at present includes the demolishing of the wings of the west side cofferdams, erected of steel sheet piling, also in preparation for diversion of the river.

A total of 6,105 men are at work at the dam, the largest number to date. A total of 19,100,000 cu. yd. of excavation has been recorded in construction of the dam.

The principal contractor for construction of the foundation dam, that which is now under construction, has completed 57 per cent of the work required under his contract in 41 per cent of the time permitted him.

Readers' Conference

Combustion Engineer

IN HIS ARTICLE on the Combustion Engineer published in your July issue N. T. Pef refers to the possibilities of smoke abatement as a field for the employment of the combustion engineer.

What Mr. Pef says is undoubtedly true, but perhaps the field is more limited than would at first sight appear. The writer at one time served upon a committee which was formed to discuss the possibility of drawing up a satisfactory smoke abatement ordinance for one of our largest cities, and perhaps it may be of interest to call attention to some of the practical points which came up.

Very early in our discussions, we came to the conclusion that our problems were quite as much legal as scientific. If a practically enforceable ordinance was to be developed, it must be based upon requirements which might be enforceable by legal means.

The most difficult problem is, of course, that of admissable evidence.

It is all very well to say that you must not make black smoke, or distribute fly ash and other products of combustion around the district, but unfortunately, you cannot catch samples of these and take them into court.

About the only thing we have for measuring smoke is the Ringlemann chart, which although not a very definite standard of smoke density, will generally be accepted in court, but evidence as to the Ringlemann density of the smoke under discussion is not only a question of the honesty of the witnesses but of the reliability of their judgment.

When we come to the question of fly ash and other more or less invisible products discharged by the chimney, the question of presenting legally adequate proof is more or less hopeless, moreover it is one thing to be morally sure that a certain chimney is causing the trouble and quite another to prove it legally.

Another matter to be kept in mind, is that the basis for all ordinances must be the welfare of the public. The taxpayers have to find the money, and the proper enforcement of smoke ordinances is a costly matter, moreover, the property owners, among whom will be generally found the owners of boiler plants, are those who have the most to say when any question of new ordinances which might affect them, comes up. If there is to be a reasonable chance of getting the proposed ordinance enacted, it must not bear too heavily on the property owner or the taxpayer.

It has been found that the most practical way of dealing with this problem is to draw up an ordinance specifying the requirements for new boiler installations, or changes in existing ones. As a rule the chief requirement is the limitation of the B.t.u. release per cubic foot of furnace volume. Sometimes the submission of drawings describing the proposed installation is required.

Although the framing of a satisfactory ordinance requires the services of a combustion engineer, its enforcement is largely a police matter. It is true that those who pass upon proposed installations should have engineering training, at the same time legally, they have very little latitude of judgment.

In reality they have only authority to enforce the ordinance as passed, aside from that they have little opportunity to exercise their knowledge of combustion engineering, and if they want to keep out of trouble, they will be very cautious about doing it.

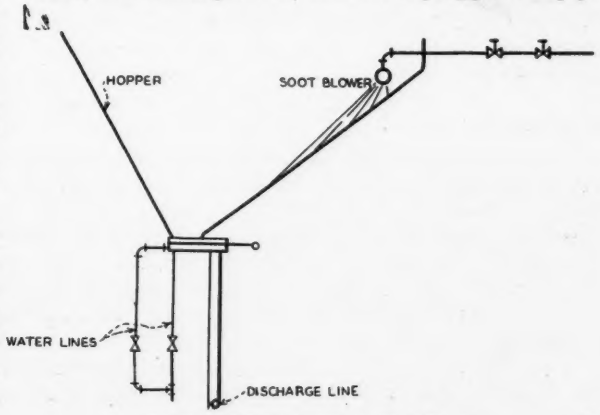
The field for the employment of combustion experts in boiler plants is undoubtedly growing, but I think that the openings for their employment in connection with the enforcement of smoke ordinances will be fewer than would at first sight appear. Of course any engineer who has anything to do with smoke abatement may call himself a combustion engineer, but owing to legal limitations he will not have much real opportunity to practice as such in the capacity of a public official.

Bloomfield, N. J. JAMES O. G. GIBBONS.

Soot Blower Eliminates Dust Disposal Troubles

THE DISPOSAL of refuse from the furnace and gas passages of the boilers in a large industrial power plant is accomplished by a hydraulic sluicing system. Ash and dust collected in hoppers located under the dry bottom type pulverized fuel fired furnaces, boiler passes, economizers, air preheaters, and at the base of the stack, is sluiced with high pressure water jets to a common sump. Centrifugal pumps having especially hardened wearing parts, pump the mixture of refuse and water from the sump to a fill some distance away.

After placing the plant in operation the ash disposal system proved remarkably trouble free, with one exception. When removing dust accumulations from the collecting hoppers under the last pass of each boiler, avalanching of the dust often plugged the pipe



Location of Soot Blower in Dust Hopper

lines leading from these hoppers to a transport trench in the floor. When this occurred it was necessary to expend considerable time and energy hammering on the lines, in an effort to restart the flow. When the obstruction finally loosened, the sudden rush of the dust and water mixture often overflowed the transport trench, creating an unsightly mess on the floor. Cleaning the floor after this happened necessitated a good deal of extra work on the part of the operating force.

An examination of these hoppers revealed that the sides had been designed with less slope than was given the sides of the other hoppers in the system. Fly ash, instead of sliding to the bottom of the hopper, would build up, over a number of operating shifts, on the upper portion of the sides and would then release, and choke the piping. As it was impossible, without excessive expenditure, to redesign these hoppers, it was decided to install a stationary soot blower to keep the top portion of the hopper sides swept clean. This soot blower, made of extra heavy pipe drilled with holes, performed so satisfactorily that no further difficulty from avalanching was experienced.

Roanoke, Va. S. H. COLEMAN.

Check-Off List Use in Boiler Maintenance

THE VALUE of a check-off list as a guide for covering maintenance is perhaps nowhere quite so great as it is in the case of the routine overhaul of large modern boilers when coming off the line. The work entailed by the overhaul and inspection extends from the power plant roof to the basement. A number of the items are comparatively insignificant and yet are of such a nature that they might require the subsequent shutdown of the boiler if not properly attended to during the shutdown period. A check-off list is therefore the best possible insurance in knowing that all the details have been attended to and in reducing the fallibility of memory to the minimum.

There follows a check-off list at present in use in an eastern industrial plant. This plant is equipped with 125,000 lb. per hr. boilers operating on either pulverized coal or oil, the former being regularly used at the present time. The pulverizers are of the unit type. The boiler is equipped with flue gas scrubbers and air heaters. The units are usually operated until 300,000,000 lb. have been evaporated before shutdown. Steam is generated at 400 lb. and 650 deg. F.

The various items on the check-off list are initialed by the chief engineer, the shift engineer or the head repairman as the case demands.

BOILERS

Before boiler comes off line note all leaks in gage lines, trycocks, alarm whistle valves, feed regulators, etc., which require attention.

When boiler comes off line close and lock boiler and header stop valves.

When boiler pressure drops to atmospheric, open water wall header and mud drum blowoff valves, dry drum drain and all vents.

Before boiler is cool, remove hand hole plates from superheater header and blow out superheater tubes with air.

Open manholes to drums and remove designated hand hole plates from water wall headers to permit inspection.

Inspect drum interiors, baffling, feed pipes, tube ends and water wall headers.

Remove soot from by-pass dampers around air heater.

Overhaul and check by-pass dampers and soot hopper doors.

Repair all leaks as covered in item No. 1.

Examine refractories in furnace bottom and front wall. Repair as necessary.

Examine coal spreaders and replace if necessary.

Overhaul Hydro-Jet ash removal system and examine quencher nozzles.

BOILER AUXILIARIES

Air Heater	Examine gas side of air heater and clean if necessary.
Scrubber	Examine interior of flue gas scrubber. Clean out nozzles on overhead water box.
Draft Fans	Examine fan blades, interior of fan scrolls and duct work.
	Flush and refill bearings.
Coal Scales	Examine mechanism and belt.
	Repack motors with grease.
	Check with test weights.
Coal Feeders	Examine interior and V belts.
	Repack motors.
Pulverizers	Remove upper half of casing and examine. Replace wearing parts as necessary.
	Flush out and refill bearings.
	Check coal pipe between pulverizers and burners for wear.
Feedwater Regulators	Examine feedwater regulators, diaphragms and differential valves.
Electrical	Inspect all starting and control mechanism for fans and pulverizers.
	Test out all interlocks.

South Amboy, N. J. GEORGE B. COALE.

Concrete Form Practice

CONCRETE FORM practice today is a matter of considerably more simplicity than it was a few years ago. It is possible, by the use of modern methods, to do a far better job than formerly, and to do it with considerably less effort. Where in other days common lumber was used for the lining of concrete forms, the use of plywood is now growing apace.

The advantage of plywood is that it comes in large sheets, and there are very few joints in the lining of a form. This means that there are very few joint marks on the finished concrete job, so that but little surfacing is required to make the job perfectly smooth. Even such surfacing as must be done is now performed with less effort, because plywood can be very closely joined. Since the adoption of this material for concrete forms is fast increasing, plywood manufacturers are furnishing material specially designed and fabricated for the purpose.

Another bugbear in concrete form practice in the old days was the spread form. At times, a form would

spread when the concrete was poured into place, and it was a hard matter to do anything about. There is a tool now in use for various pulling jobs that works to good advantage in pulling concrete forms together, if it is applied promptly, before the mixture has begun to set. It consists of a tail chain and a load chain, together with an ingenious arrangement of sprocket wheels, ratchets and pawls. The tool is, of course. adapted to countless other pulling operations around the plant.

Peoria, Ill. JOHN E. HYLER.

Reducing that "Unaccounted for" Loss

PROFESSOR MOHN writes in your August issue, page 456, that unaccounted for losses may be reduced by correcting tests for air leakage for example, around mud drums. His theory seems to me quite wrong. The heat rejected by the boiler gases is given at the point where the flue gas analysis and temperature are measured quite accurately. It includes all excess air leakage up to that point. Splitting this loss into two parts one of which is due to air leakage may be interesting but will not reduce the unaccounted for loss one bit. Adding the loss calculated by Professor Mohn to the measured losses reduces the unaccounted for, the only trouble being that he has added the same loss twice. Ordinarily air leakage does not affect heat balance one way or the other providing the proper sampling points are used for the gases. Of course, it does affect the efficiency either for the better or the worse.

New York, N. Y. A. A. MARKSON

THE WRITER is indebted to Mr. A. A. Markson for calling attention to the misuse of the term "unaccounted for loss" in the first sentence of the article. The leakage loss is unaccounted for as a separate item but is, as he points out, included in the gas losses. It was the purpose of the article to evaluate the probable loss due to leakage.

EDITORS NOTE: A private communication to Professor Mohn stated that methods similar to that described by him are used for calculating leakage losses through boiler settings. A coefficient of 0.6 has been used for that purpose and the opinion was expressed that a coefficient of 0.2 is low. Inasmuch as the calculated volume of air varies directly as the coefficient used, selection of a coefficient is a matter of some importance, the two values given above representing a difference of 3 to 1 in the final answer. The following paragraph is Professor Mohn's comment on this point:

The writer has also been informed that a coefficient of 0.6 is sometimes used in estimating leakage losses, whereas a coefficient of 0.2 was used in the calculations presented. As a coefficient of 0.6 is identical with the coefficient for the flow of air through a square-edged thin-plate orifice of symmetrical form, the writer does not consider it applicable to flow through cracks. The cracks considered are not of uniform shape and form comparatively long passages lined by rough walls. The coefficient used was considered more nearly in keeping with the character of the openings in question.

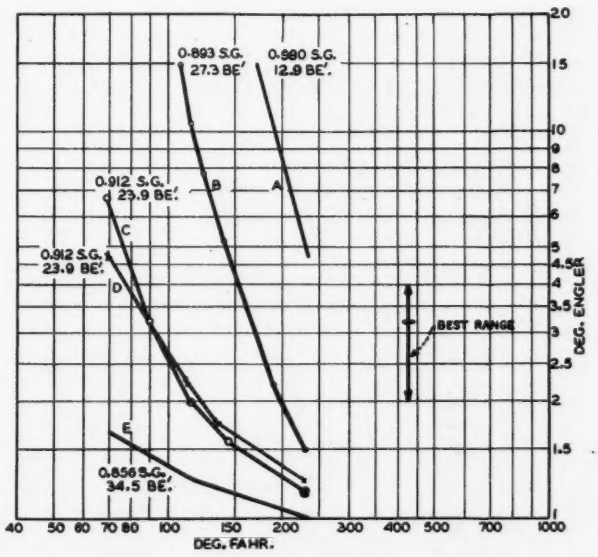
Urbana, Ill. P. E. MOHN.

Oil Temperature Gravity Relations

One point touched upon by Mr. Gibbons in his article on oil burners in the August issue I think worth commenting on, as it is a matter of prime importance to the operating man and that is the matter of the proper temperature for atomization mentioned on page 462. Specific gravity or degrees Bé used to be the most widely used characteristic of fuel oils and due to the limited number of fields, the absence of cracking residue and perhaps less attention to efficiency it served as a fairly reliable guide to the temperature to which oil should be heated for proper atomization.

It is interesting to note, however, that specific gravity has disappeared from fuel oil specifications and even though it is known it is of no value in determining the best temperature. It may, however, be a point of interest because it bears a straight line relation to heating value, the curve passing approximately through 20 Bé, 19,000 B.t.u. and 45 Bé, 20,000 B.t.u. both values of gravity being taken at 60 deg. F. The lighter the oil the higher the heat content per pound but the lower the heat content per gallon due to the lower specific gravity. This is a point worth remembering because oils are purchased on a volume basis.

Today the best method of determining the proper



Temperature-Specific gravity Relations of several oils

temperature to use is the viscosity. This has been determined by the Navy and probably by others to be in the range 2 to 4 deg. Engler with the best point at about 3.2 deg. No reliance can be placed on the specific gravity determination as is shown by the curves that I have drawn for some oils on which I happen to have some information. The temperature viscosity characteristic is different for different oils.

The top one is a heavy California oil with a specific gravity of 0.98 the bottom one is a light Mexican oil with a gravity of 0.856. The two together are both California oils with a gravity of 0.912. So far there seems to be a relation between viscosity and gravity but if that were the case, B, an Illinois oil, should come down around E. Another Illinois oil with the same gravity as B comes in the same position as C and D and has been left off for that reason. Oil B would be at the proper viscosity at about 165 deg. F. while the other oil of the same gravity and from the same location would be alright at only 90 deg. Other oils

show greater differences but these are all for which I happen to have the data.

Heating higher than necessary wastes steam but that is the least of the operating man's worries, excessive heating causes carbon precipitation from many of the cracked oils and this carbon collects in the tanks, lines, heaters, burners and furnace. It has been suggested that specifications should give a temperature beyond which the oil cannot be heated without danger of excessive carbon deposits but this is perhaps beyond the point that oil companies can go commercially at present, perhaps it will come later.

It must not be inferred, however, that these cracked fuel oils are inferior fuels just because they happen to mix up the atomization temperature a trifle. A few years ago when they first appeared they caused more than a trifle of trouble. As a matter of fact they make excellent fuels, high in B.t.u., low in viscosity although heavy, and so requiring less live steam for heating, and easy to move because the paraffins have been removed or broken down so that many of these oils will pour even at 0 deg. F.

To avoid carbon precipitation which sometimes takes place slowly over a considerable period the storage tank should not be heated but the heaters if used should be arranged so that they heat but a small localized area and a small amount of oil as it leaves the tank.

Brooklyn, N. Y. P. F. ROGERS

Faulty Draft

I READ with interest your article on mechanical draft troubles in the May issue of Power Plant Engineering. As we have had some trouble with the turbine driving the induced draft fan in the plant where I am engineer, I have been checking up on the air leakage into the system since reading this article.

I am enclosing a rough sketch of the boilers and uptake and stack. As we have no damper in the common uptake between the big boiler and the three boilers shown in the sketch, we always get some air leakage into the main uptake from the old boilers.

Does the leakage of air through the old boilers impair the efficiency of the induced draft fan or tend to overload the turbine driving the induced draft fan? The induced draft fan is below the common uptake and discharges into it. The forced draft fan (not shown in the sketch) is situated alongside of the induced draft fan and forces the hot air from the exposed half of the preheater through a wind box down into the furnace.

Would appreciate it greatly if you would look over enclosed sketch and pass opinion on the advisability of isolating completely with a tight damper the old boilers from the big boiler. Do you think that it would help the performance of the induced draft fan?

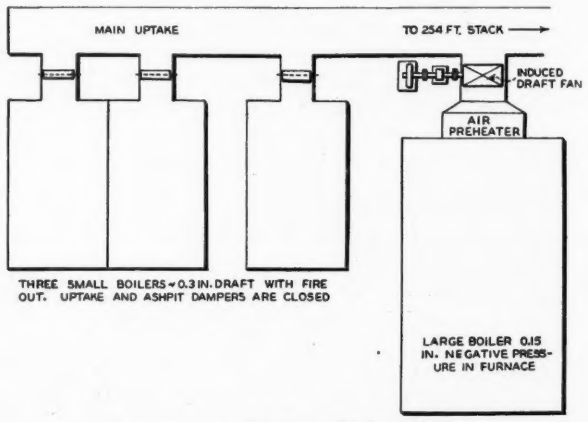
P. R. M.

After looking over your sketch it appears that the induced draft fan should not be affected by any leakage through the settings of the three small boilers. It may be that if you were to place a damper in the main breeching between the three small boilers and the large boiler you might be able to operate the large boiler at normal load at considerably reduced speed, since there ought to be sufficient draft from a stack 254 ft. high to take care of normal resistance through both the boiler and air heater.

Since you have not given any data regarding the rated capacity and desired maximum loads of any of these boilers, nor the size of the up-take and the area of the stack, I cannot tell you just how much improvement you would get.

Are you having trouble at present in reaching the desired maximum capacity with the large boiler when the others are shut down? What is the size and type of the air preheater?

I assume that the forced draft fan is operated in the usual manner in that it forces cold air into the heater where it is heated and from there passes through a duct to the furnace. If this is not the case and the forced draft fan actually handles hot air, it is taking considerable more power than it would if it were handling cold air. Your statement regarding this fan is not clear, since you say "Forces the hot air from the exposed half of the preheater through a wind box down into the furnace."


MAIN UPTAKE
TO 254 FT. STACK
INDUCED DRAFT FAN
AIR PREHEATER
THREE SMALL BOILERS - 0.3 IN. DRAFT WITH FIRE OUT. UPTAKE AND ASHPIT DAMPERS ARE CLOSED
LARGE BOILER 0.15 IN. NEGATIVE PRESSURE IN FURNACE

Arrangement of boilers and breechings

If you are not having any trouble at present with the induced draft fan and can get the maximum load desired there will be no point in installing a damper in the main breeching, although you might get a saving in steam consumption by running the turbine at lower speed, but here again if you have use for all of your exhaust steam, reducing the steam consumption of the turbine might not matter. I would need to know more about your operating conditions to advise you further.

J. R. DARNELL.

A.I.E.E. South West District Meeting

DALLAS, TEXAS, will be host to a 3-day meeting of the South West District of the American Institute of Electrical Engineers which will be held from Monday to Wednesday, October 26-28, 1936. Headquarters will be at the Adolphus Hotel, where 5 technical sessions, 2 student sessions, several luncheon meetings, and the dinner-dance will be held. An attractive program is offered and those who will attend are especially urged to do so for the full duration of the meeting.

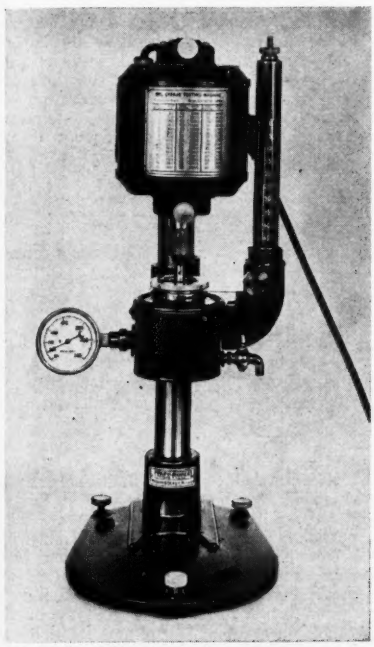
Some of the interesting subjects are: a new telephotograph system, electrical features of the Texas Centennial Exposition, carrier current relaying, lightning and surge-protection, rural electrification, electric arc welding, and d.c. equipment for oil well drilling.

New Equipment

Grease Tester

DESIGNED and developed by the Bearing Engineers' Committee, this new device is now offered to manufacturers and extensive users of greases and bearings by the Taft-Peirce Mfg. Co., Woonsocket, R. I., as a means of determining the mechanical stability of heavy lubricants.

The machine works a definite amount of grease in a moderate sized bearing running at medium speed, at various test



temperatures. And while it does not indicate the lubricating value of the grease, it does give definite information on starting and running torque, oil separation, change in structure and consistency, channeling, leakage past bearing seals, aeration and the consequent increase in grease volume.

The unit is equipped with a constant-speed, 3450-r.p.m. motor, on the spindle-extension of which is mounted a plate-shielded, size 204 SAE bearing. The bearing is mounted in a grease cup which is free to turn, and the grease is brought to a predetermined temperature which is recorded by a dial thermometer. Accessories consist of a grease-measuring cup, melting point apparatus, and the BEC Penetrometer.

Control Instruments

THE BRISTOL CO. announces a new pneumatic-type controller for temperature, pressure and liquid level. Known as the Model 90 Controller, this instrument has been developed to take care of the many requirements for automatic temperature and pressure control that do not warrant a chart record of the controlled temperature or pressure, and also, for applications where recording instruments already are in use.

This is a small, compact instrument of simple construction, which embodies the latest developments in automatic control. The outstanding feature of this controller is its precision measuring element. This is of the same type as those employed in Bristol's Recording Instruments, where accuracy is of prime importance.

The instrument is equipped with a wide-range sensitivity adjustment. It can be changed from direct to reverse acting, or vice versa, by the user without additional parts. The case is moisture-, fume-, and dust-proof and is offered in two forms,—for wall and for flush panel mounting.

Bulletin No. 444, giving complete information is available from the manufacturer.

Switchgear

THE INSTALLATION shown herewith which is operated from a distant point, has in each of its four units (reading from left) a three pole, 800 amp. solenoid operated oil circuit breaker with its current transformers, relays and plug dis-

connectors with their interlocks. The main bus is in the top compartments.

The right hand, or fifth unit, houses three potential transformers and a three-pole group operated disconnecting switch interlocked with the door. The fuses, mounted on the switch frame, are equipped with limiting resistors. It is made by Delta-Star Electric Co., Chicago, Illinois.

Coppercote

THIS NEW preservative coating for wood, metal and other surfaces is a pure metallic copper of extreme fineness and of the irregular flaky structure known as "dendritic."

Corrosion in its various forms costs the American people approximately three billion dollars a year according to the U. S. Bureau of Foreign and Domestic Commerce, while the ravages of the teredo, limnoria and other marine borers on marine wooden construction in the United States are estimated to be in excess of fifty million dollars a year, with the destructive activities of termites resulting in additional losses of many millions of dollars annually.

While the coating is applied, a physico-chemical reaction occurs between the particles of copper and its vehicle, giving a closely knit coating to form a tough hard metallic surface. On ferrous metal it is claimed to prevent corrosion, or for a surface already rusted, to arrest further corrosive action. Also that it does not crack, scale nor chip as a result of extremes of temperature.

Action which takes place when coppercote is applied throws off air bubbles and closes pin holes, also there occurs a definite stratification of the metallic copper and its vehicle, the copper particles adhering closely to the base while the vehicle rises and forms a second protective film. This permits the use of various colors in the vehicle.

Coppercote has been demonstrated, it is stated, to be a non-conductor of electricity, hence destructive electrolytic action is impossible. It is fire resistant and serves effectively to waterproof concrete. It is a product of American Coppercote, Inc., of New York City.

Out-of-Step Relay

A NEW RELAY to prevent continued operation of synchronous machines out of sychronism with their connected system, or to function to separate large interconnected systems at a specific location in the event of an out-of-step or unstable condition between the sources of power on both sides of this location, has been announced by the General Electric Co.

The out-of-step relay consists of an instantaneous overcurrent unit, a single-phase power-directional unit, an auxiliary unit to increase the operating speed, a notching device, and a time-delay element for resetting the notching device. All these are mounted in a standard 5½ by 16 in. universal case. A capacitor and resistor for the notching unit are mounted externally.

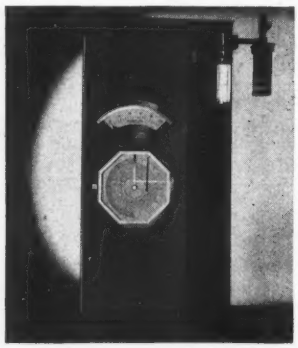
The device operates on an overcurrent and power-directional principle. When two synchronous machines, or groups of machines, pull away from each other in phase angle, the current and power interchange increase. When this action proceeds far enough, i.e., approximately 90 deg. between the internal voltages, the over-current unit picks up its contacts to energize the armature coil circuit of the polarized auxiliary unit. As the phase angle continues to increase, the current likewise increases, but the power interchange decreases, and at about 180 deg. between the internal voltages the power reverses. This causes the power directional unit to function and through the closed contacts of the auxiliary unit causes the notching device to step up one notch. At 540 deg. the second notch is stepped up and at 900 deg. the third, causing the main contacts to close in the tripping circuit of the circuit breaker to disconnect the machine. The relay is provided with

a target which gives visual indication after operation. The contacts are automatically reset after a time-delay, but the target must be reset manually.

The notching unit, in each of its notch-steps, closes contacts in the coil circuit of the timing unit. This coil circuit also includes the normally-closed contacts of the overcurrent unit so that when the first notch is made and the overcurrent unit drops out as the angle approaches 360 deg., the timing unit begins to operate. If the overcurrent unit fails to receive another impulse within the time setting of the time-delay unit, the contacts will be reset. This same action can take place after the second notch if the protected machine slips two pairs of poles and then stabilizes. It will always occur after the closing of the contacts on the third notch has tripped the circuit breaker.

Co_2 Meter

LATEST DEVELOPMENTS in the measure-of CO_2 are incorporated in a new design of CO_2 meter announced by the Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill. The per cent CO_2 in the flue



gas is measured by the Orsat method, and the meter is built to duplicate, mechanically, this chemical analysis. Its meter is driven by a fractional horsepower electric motor and requires no water for its operation. Possibility of stoppage in the gas line is eliminated by a suction capable of drawing 14 in. of mercury. The large caustic tank holds enough potash to last from 4 to 6 mo. Temperature variations have no effect on the meter readings.. A filter in the gas line removes all SO_2 from the flue gas before it reaches the analyzer. A permanent continuous, pen line record is inscribed which may be read directly in per cent CO_2 and arrangements of indicators and recorders may be made to fit any requirement. Related factors, such as steam flow, temperature, draft, pressure, etc., may be combined on one circular chart.

V-Belt Coupling

THE SHIPPERT MFG. CO., 414 So. Galena Ave., Dixon, Ill., has recently announced a new type of coupling for V belts.

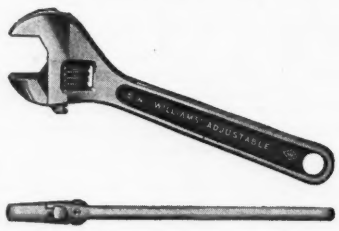
The new coupling, known as the "Grip-Flex", is made in standard sizes and in a variety of types to suit the size and strength of the belts.

Features of its construction include anchor plates which completely surround the ends of the belt so that no strength is lost in attaching the coupling, trailer pins to ease the strain of heavy loads and shocks, side plates and replaceable roller bearings.

Unusual strength is claimed for the "Grip-Flex" method of coupling. Ease of attachment in tight places is also an important feature. It is possible, according to the manufacturer, to attach a "Grip-Flex" coupling in as little time as five minutes.

Wrenches

J. H. WILLIAMS & CO., 75 Spring St., New York City, announce two new lines of Adjustable Wrenches—both embodying new design features. Square shoulders on the movable jaw shank are said to over-



come the wedging and spreading action common to the conventional cylindrical bearing and to provide a positive bearing against working stress. This design permits a thicker and stronger "web" without increasing a total head thickness of the wrench.

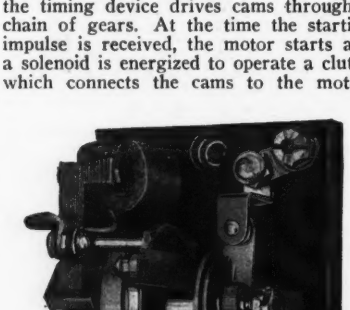
Williams' "Adjustable" Wrenches are drop-forged from a special carbon steel which gives them unusual strength. This line is supplied in a natural polished steel finish.

Williams' "Superjustable" Wrenches are forged from Chrome-Alloy Steel providing a well-balanced tool of trim design . . . thin, light and strong. This line is finished in chrome-plate with highly polished heads and "satin" finish handles. Both lines are available in five sizes, 4, 6, 8, 10 and 12 in.

Timing Device

STRUTHERS DUNN, INC., Philadelphia, Pa., have recently added several motor operated timing devices to their line.

One of these is of the immediately recycling type. The synchronous motor of the timing device drives cams through a chain of gears. At the time the starting impulse is received, the motor starts and a solenoid is energized to operate a clutch which connects the cams to the motor.

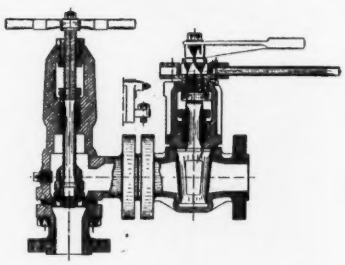


At the end of the cycle, the motor is de-energized by means of a contact on one of the cams, and the clutch holds the cams in position. When the solenoid is de-energized, the cams are returned to the starting position by means of a spring. The timing is adjustable over a wide range and practically any desired arrangement of load contacts may be furnished.

Another of these timing devices is of the continuously rotating type. By means of gears the cams of the timer are made to revolve at 1 r.p.m. or any other desired speed. The contacts can be arranged to be closed for any time up to half the time required for one revolution if the timing is adjustable, or up to the full revolution time if the timing is not adjustable. Almost any desired number of adjustable or non-adjustable contacts can be furnished.

Plug Valve

HOMESTEAD VALVE MFG. CO., Coraopolis, Pa., announce a new valve incorporating in its design positive mechanical seating and unseating. It is known as the two-handle lift-type plug valve and has been designed to overcome operating obstacles encountered with high temperatures, high pressures, infrequent operations, corrosion, etc., met in power plants,



steel mills, refineries, oil fields, paper mills, chemical plants, etc.

A mechanical leverage lifts the plug vertically from its seat sufficiently to break the friction between plug and body and allows for the free rotation of the plug. By the same process, the plug is mechanically reseated. The body of the valve is streamlined to reduce friction loss. Pressure range is from 125 and up, and temperature up to and including 750 deg. F. Valves for pressures up to 250 lb. per sq. in. are made of iron; for all other higher pressures they are of bronze or of cast steel construction with alloy trim best suited for the service required.

The illustration shows the new Homestead Blow-off Combination. Here the two-handle lift-type plug valve becomes the companion to the regular Hovalco angle blow-off valve, thus obtaining the ideal for the modern plant blow-off service. The combination may be had in all iron for the lower pressures, and in cast steel construction with suitable alloy trim for the higher pressures.

Plastic Packing

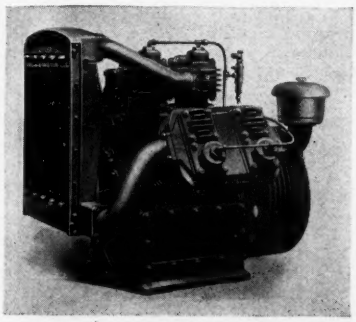
"SUPER-SEAL," a general, all-service plastic packing with a new anti-frictional, dry-graphite lubrication is announced by the Crane Packing Co., 1802 Cuyler Avenue, Chicago, Ill. This packing provides a permanent anti-frictional seal, is resilient and without tendency to harden or dry out, flows readily under gland pressure, making it easy to adapt to smaller or larger packing spaces.

Super-Seal is composed basically of extremely fine particles of a new alloy. The special high temperature binder completely covers and saturates each particle of alloy and each strand of long fiber asbestos, and contains pure flake graphite; and is processed for even distribution and resistance to high temperatures.

Super-Seal anti-frictional plastic packing is engineered for all-around packing service in power plants, refineries, chemical plants, the process industries, paper mills, for marine service and industrial works of all kinds. For widest application and ease of handling, it is put up in six convenient forms: Valve stem (round), spiral form (rectangular), coil form (square), bulk form (for emergency use), ring form (split), and production sets (endless).

Compressor

COMPACT, SELF-CONTAINED three- and six-cylinder, vertical-angle two-stage compressors are now offered by Worthington Pump and Machinery Corporation, Harrison, N. J. Capacities range from 142 to 445 c.f.m. The three-cylinder unit has



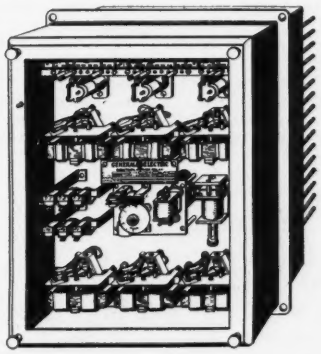
two low-pressure cylinders set opposite each other at an angle, with a high-pressure cylinder set vertically between them. The six-cylinder unit is set up in the same manner, with two cylinders side by side in each position. The units may be had with Worthington Multi-V-Drive, direct-connected to the motor through a flexible coupling, or with the motor mounted directly on the end of the crankshaft. The compactness of this unit combined with the variety of drives available, makes it easily adapted for any installation.

High-Speed Relay

A NEW HIGH-SPEED, three-phase, directional distance relay, known as Type GCX12A, which combines all the functions of the three commonly required devices in one relay, completely assembled and tested, and ready for installation, has been announced by the General Electric Co. The new relay requires simply connecting the current and potential transformer leads and the control circuits to studs on the case to complete the installation. The combining of all the relaying components for the three-phase line in one case assures complete coordination of the units and considerably simplifies the installation.

The new relay consists of three starting units, three resistance units, and one timing unit. In addition, there are two instantaneous overcurrent units, one for each of two phases, whose function is to prevent tripping on fault currents less than their setting. These units are connected with coils in series, with the current windings of the starting units and their contacts in series with the main tripping contacts. Each overcurrent unit has calibrated settings of 4, 7 and 10 amp.

Operating time on phase-to-phase faults in proximity to the relay will range from one to one and one-half cycles with corresponding currents of 20 to 10 amp.



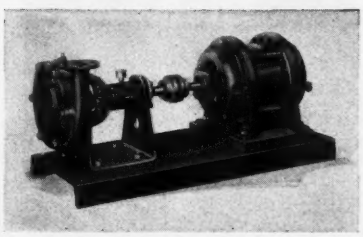
With remote faults the time will increase, due to the restraint which is derived from the line drop between the fault and the relay.

The relay is mounted in a case 16 in. wide by 20 in. high, with an 18 by 22 in. mounting flange. The case is 7 in. deep to the base, and there is a 6-in. extension through and back of the panel. In appearance the device matches the G-E universal case line of relays and switchboard meters.

Acid Pump

A SMALL, low cost, centrifugal pump made of Worthite, an acid resistant nickel-chromium-molybdenum steel, is announced by Worthington Pump and Machinery Corp. of Harrison, New Jersey. All parts of the liquid end of this pump are of Worthite. Acid resistance of other parts is obtained by using specially treated steel, coated with chlorinated rubber.

The impeller is of the open type, with three vanes opening down to the hub. This construction subjects the stuffing box

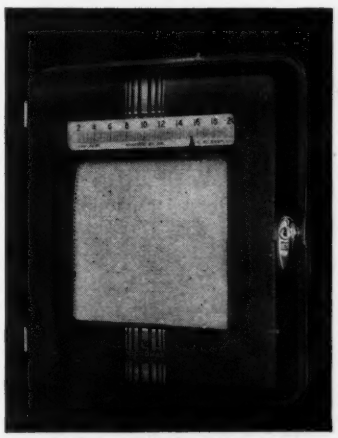


to suction pressure only. The shaft is one solid piece of Worthite. The casing is of the full volute type.

This pump is adapted to handling most acids and alkalies where medium-pressure, transfer pumping is required. Heads available to 70 ft., and capacities to 130 g.p.m.

Industrial Recorder

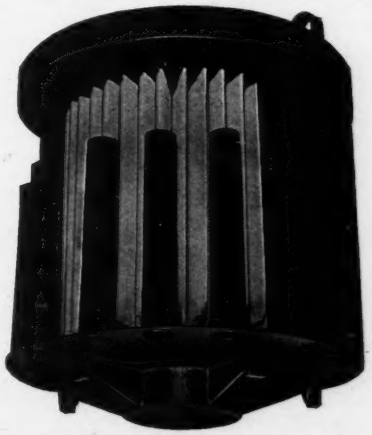
SILVER ANNIVERSARY Micromax recorder, latest of their long line of industrial recording machines, has just been announced by Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa. Marking the 25th year since this concern originated the recording potentiometer pyrometer, this Micromax not only provides in the one instrument all combinations of indicating, recording, signaling and controlling, but provides these functions in ways unique to this model. Measurements are presented most conveniently; a bold scale and pointer shows the condition at the moment, and a clear record on ten visible inches of strip-chart shows it for the past several hours. On controllers, a second pointer shows control setting. Multi-point records may be in blue or in multi-color.



In this Micromax, control and signal contacts operate undisturbed by air currents when the door is opened . . . even when the chart is changed, or the pen refilled. Pen holds seven-week ink supply. An ingenious double frame makes all parts of the mechanism strikingly accessible, and enables the user to replace the chart without effect on other parts of the recorder.

Silencer Filter

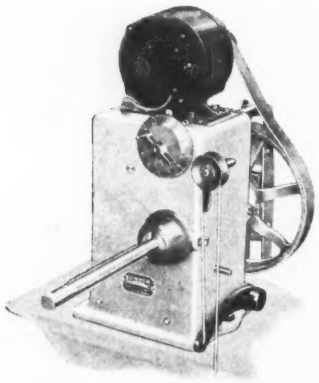
SIMPLE AND EFFECTIVE silencer-filters based upon the Protectomotor filter principle of circular fin construction combined with a positive dry Feltex filtering medium, has been announced by The Staynew Filter Corp., Rochester, N. Y. This basic Protectomotor principle has been adapted to a silencer unit as shown by the illustration. Air is drawn in through a series of circular rectifying chambers



welded air tight to the supporting base. The air is then distributed at a lower velocity to the insert where filtering occurs; this sudden lowering of the air velocity from the rectifying chamber takes the pulsating thump out of the compressor intake.

Honing Machine

SUNNEN PRODUCTS CO., 7900 Manchester St., St. Louis, Mo., have developed the Sunnen Precision Hone for grinding, honing and lapping holes in all kinds of metal except lead or babbitt. No particular skill is required to operate and hold work within limits of 0.0001 in. The machine will handle any hole from 0.480 to 2.400 in. in dia. that is free from keyway



and not more than 7 in. in length. Can be set up for any job in one minute maximum time. Duplication of size is easily maintained by means of a micrometer stop graduated in 0.0001 in.

The Precision Honing Machine is especially suited for assembly operations, short run production, tool room and experimental work, and general plant maintenance. Can also be used sizing regular production pieces where shaft or hole is under or over size.

PREPARATIONS for the National Exposition of Power and Mechanical Engineering, to be held on three floors of Grand Central Palace, New York City, Nov. 30 to Dec. 3, have advanced to a point where the display of machinery and equipment can be outlined. Pumping equipment will include vacuum and compressor type air pumps as well as liquid pumps; also regulating and flow-reversing valves, filters and strainers. In transmission equipment will be shown ball, roller and thrust bearings with their adaptation to pillow blocks; chain drives; herringbone, worm and helical gears; variable speed transmissions; all steel and flexible couplings; belt drives and accessories. Piping exhibits will include valves and fittings, welded construction, pipe tools and machines, special blowoff valves. In refractories will be found wall construction for solid and for air-cooled walls, arches, building insulation and a new high-temperature cement. Electrical equipment will display all kinds of control for flow of current, relays, motor starters and voltage regulators. Precision instruments will demonstrate measurement, flow regulation and recording for all kinds of fluids. The Exposition is, as heretofore, under the management of International Exposition Co., Charles F. Roth, manager, Grand Central Palace, New York, N. Y.

Edge Moor Reorganized

EDGE MOOR IRON CO. has been purchased in its entirety by new interests and will resume full operation immediately, under the name of Edge Moor Iron Works. The new company is capitalized at $1,000,000, and will be under the management of Thomas J. Dillon, of New York, President; Percy R. Gardiner of Toronto, Canada, Vice-President, and John H. Shively, of Wilmington, Delaware, Secretary and Treasurer. Members of the Board of Directors include: Ronald C. Graham, Paul Leahy and Evan B. Quinn, in addition to the officers.

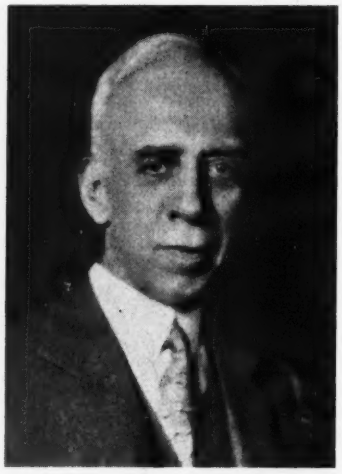
Mr. Dillon has long been identified with the iron and steel industry in the United States and Canada. In addition to being co-receiver for the Edge Moor Iron Co. with Mr. Cox, Mr. Shively was also the former Vice-President and Treasurer of the Edge Moor Iron Co. for several years.

In addition to boilers, water walls, economizers, and other major power plant apparatus, the company will also operate as fabricators in iron, steel and alloys.

H. W. Fuller

H. W. FULLER, vice president in charge of engineering and construction, Byllesby Eng. & Mgt. Corp., died suddenly on August 28. Funeral services were held Tuesday, September 1, in Chicago.

Mr. Fuller was born in New York, received his primary education in the public schools of Bayonne, N. J., and State Model School of New Jersey and graduated from Rutgers College in 1891. He entered the electrical industry immediately after his graduation, his first work being in connection with the electrification of the horse car lines at Patterson, New Jersey, in 1891 and 1892. For a short time in 1893 he was employed by the General Electric Co., leaving that connection in 1894 to join the Consolidated Traction Co. of Newark, N. J. He remained with this company and its successor, the Northern New Jersey Street



Railway, as superintendent and assistant general manager until February, 1901. At that time he became general manager of the Washington Railway & Electric Co. and the Potomac Electric Power Co., which position he occupied until December, 1911, when he joined the Byllesby organization.

Mr. Fuller's first service with the Byllesby company was as vice president and general manager of the Appalachian Power Co., Bluefield, W. Va. Following the completion of construction work for this property and the organization of its operating forces, he became vice president of Louisville Gas & Elec. Co. in January, 1913, and remained in Louisville during the consolidation of the various companies there and the reorganization of the operating department.

In September, 1913, Mr. Fuller entered the Chicago office of the Byllesby company, remaining there until February, 1918, when he was made vice president in charge of operation of Northern States Power Co., which position he held until his election in 1924 as vice president in charge of engineering and construction of Byllesby Eng. & Mgt. Corp. He was also a vice president and director of Standard Gas & Elec. Co. and a director of Standard Power & Light Corp., Northern States Power Co., Philadelphia Company, Duquesne Light Co. and Louisville Gas & Elec. Co.

J. E. Buckingham

ANNOUNCEMENT is made of the election of J. E. Buckingham as Vice President in Charge of Sales for the Western District of the Lincoln Electric Railway Sales Co. with headquarters at 310 South Michigan Boulevard, Chicago, Ill. Mr. Buckingham began his railroad career in 1900 with the Union Pacific System, continuing 8 yr. at Salt Lake City and Omaha. Later he was identified with the Wells Fargo Express as superintendent of Motor and Refrigerator division, also had experience with Baldwin Locomotive Works, The Standard Steel Co. and Associated Oil Co.

For the past 14 yr. he has been connected with The Worthington Pump and Machinery Corp. in their railroad sales, the last five as western regional manager. He was an officer in R. R. Unit, U. S. Army Co. D 87th Engineers during the war.

The Lincoln Electric Railway Sales Co. was appointed several years ago by The Lincoln Electric Co., Cleveland, Ohio, as exclusive railroad sales representatives covering its entire line of "Shield Arc" welders, electrodes and motors. Growth has necessitated repeated expansion and Mr. Buckingham will continue this as necessary.

Frederick S. Cook

FREDERICK S. COOK has been appointed Pacific Coast manager for Robert W. Hunt Co., Engineers, and will make his headquarters at San Francisco, Cal. Mr. Cook is a graduate of Columbia University, 1905, and has had extensive mining expèrience in the Joplin, Mo., district. He served as captain in the engineers' corps during the war and since 1919 has been vice-president and secretary of the McCracken-Ripley Co. of Portland, Ore.

News from the Field

HAGAN CORPORATION AND HALL LABORATORIES, INC., of Pittsburgh, Pa., announce reorganization and expansion of its Philadelphia representation, to make possible coverage of the field of combustion control and boiler water conditioning with greater effectiveness, in line with its "Dual Service" policy of considering combustion control and water conditioning as related phases of the same industrial problem.

Two additional men, working with Allen-Sherman-Hoff, representatives in the Philadelphia and adjacent territory, will enable all representatives to handle Hagan combustion control, Hall systems, Buromin and textile Calgon. David A. Los Calzo, who spent 8 yr. in the mining field, and for 2 yr. has been with Allen-Sherman-Hoff in Philadelphia territory will cover territory in Western Virginia. E. F. Kuehnle, since 1933 mechanical engineer with W. K. Mitchell Co. in sales work on power piping, will cover territory north of Philadelphia, G. C. Parr, who has handled combustion control and Calgon, will act as "liason officer" on all Hagan-Hall accounts. A. M. Quinn, who has handled Buromin and Hall systems, will take on combustion control and Calgon for territory south of Philadelphia, extending into Virginia.

Another change in the organization is the addition of William R. Gibson with large experience in the pulp and paper industry to the staff of Kenneth Shibley of Seattle, Wash. Mr. Gibson originally hailed from Glasgow, Scotland, and was for 8 yr. in charge of construction and erection work there. For 4 yr. during the world war, he was in charge of water supply and pipe lines mostly in Egypt and Palestine. Coming to North America, he spent 4 yr. with Whalen Pulp & Paper Co. of British Columbia and later was chief engineer for Zellerbach Corp., also acting as consulting engineer on power plant problems for the mills of that concern. He, as well as Mr. Shibley, has had wide contact with the problems of water conditioning to secure steam of the purity necessary in the processes of paper making.

FEATURES of the National Exposition of Power and Mechanical Engineering, to be held in Grand Central Palace, New York, Nov. 30 to Dec. 6 will be operating exhibits and working models, with colorful display, to give quick lessons about new developments. Some of the labor-saving exhibits will cover prevention of dust hazard in factories, handling of heavy loads for stacking, storage and manufacturing processes, packing and lubrication, making joints in belts, spray methods for cooling and air washing, use of compressed air, pumping equipment.

THE FLYNN AND EMRICH CO. has been awarded contract to furnish its overfeed stokers for two 250-h.p. and five 300-h.p. horizontal water tube boilers in the new power plant of the Metropolitan Hospital on Welfare Island, New York City. The fuel to be used is a mixture of No. 4 buckwheat, anthracite, and bituminous coal screenings.

WALKER D. HANNA, investment banker of Burlington, Iowa, has become associated with the Burlington Instrument Corporation, makers of voltage regulators, and elected president of that corporation.

OFFICERS chosen by the Stoker Manufacturers Association for the coming year are as follows: Ray C. Goddard, vice-president of the Steel Products Eng. Co., president; Louis Schwitzer, president of the Schwitzer-Cummins Co., vice-president; Max H. Hurd, vice-president of Link-Belt Co., treasurer, and Marc G. Bluth, Chicago, was re-elected secretary. The association is planning a comprehensive program for the ensuing year which was mapped out by members attending the convention held last June.

OHIO WESLEYAN UNIVERSITY has conferred the honorary degree of Doctor of Science on Dr. Ralph Emons Hall, head of Hall Laboratories, Inc., Pittsburgh. This degree was conferred by the Board of Trustees as a recognition of outstanding accomplishments in the field of boiler water chemistry.

HAGAN CORP. and Hall Laboratories, Pittsburgh, Pa., announce that they will be represented by Joseph W. Eshelman & J. T. Potter, Inc., of Birmingham, Ala. This new firm will specialize in the sale of combustion control equipment and for scientific treatment of water in steam boilers.

THE BOARD OF DIRECTORS of Byllesby Engineering and Management Corporation recently voted to change the name of the organization to Public Utility Service Corporation, and elected B. W. Lynch as president of the new corporation succeeding the late John J. O'Brien. Mr. Lynch is also president of Standard Gas and Electric Company.

Byllesby Engineering and Management Corporation was organized in 1919, to render engineering and managerial services to public utility and other companies but particularly for those companies comprising the Standard Gas and Electric Company system. In September, 1935, the stock of the management corporation was sold without profit to these companies by Standard Gas and Electric Company and the corporation then functioned as a service organization on a cost basis to the companies acquiring it. The purpose of the change in name from Byllesby Engineering and Management Corporation to Public Utility Service Corporation is to more clearly indicate existence of Public Utility Service Corporation as a separate and distinct organization from H. M. Byllesby and Company, the investment banking house.

GLEN J. CHRISTNER, formerly in charge of the Eagle-Picher Lead Co.'s New York Insulation Division, was recently transferred to Cincinnati as Manager of the entire Insulation Division. Christner was graduated from the Missouri School of Mines in 1922. He was then associated with the American Bridge Co., later joined the Ingersoll-Rand organization, with which he was sales engineer, and became manager of a sub-branch and was then assigned to Tokyo, Japan, for one year. His latest experience was in opening and developing the New York market for Eagle-Picher, making him particularly well suited for his new position.

HEADQUARTERS OFFICE of Power Transmission Council and Mechanical Power Engineering Associates has been moved from 1 Atlantic St., Stamford, Conn., to 75 State St., Boston, Mass.

O. H. WOOLFORD, formerly manager of the Flow Meter Division, has been made Executive Officer of the General Sales Department of Cochrane Corp., Philadelphia, Pa. Sales activities of the various divisions of the company will be coordinated under the newly created office. Mr. Woolford has been associated with Cochrane for the past 10 yr., previous to that time having been on the faculty of Princeton University. Announcement is also made that Chester H. Jones has been appointed Sales Director of the Specialties Division.

D. H. SKEEN & Co., One LaSalle Street, Chicago, managed by Mr. Kenneth Williams, formerly in charge of the Industrial Engineering Sales for H. M. Byllesby & Company, have been appointed sales representatives for the Geo. P. Reintjes Company for the sale of their supported walls and arches in the Chicago area.

J. McC. MOFFETT, of the Midwest Piping and Supply Co., died from a heart attack while working in his office on Saturday morning, September 5, 1936. He served in the capacity of Vice President in Charge of Sales since the formation of Midwest in 1920, and had much to do with the success of that company. Previous to the formation of Midwest he was Vice President of the Urbauer-Atwood Co., piping contractors, and before that was identified with the Chapman Valve Co., Kansas City Steel Railways and the Standard Oil Co. of Indiana.

J. F. STONE, who has been assistant manager, has been appointed staff manager of the refrigeration section of the insulation department of Johns-Manville, as announced by T. K. Mial, vice president. He will have charge of cork sheets and blocks, cork pipe covering, hair-felt pipe covering and other insulations for low temperature work.

W. I. BROCKSON, formerly advertising and sales promotion manager for Steel Sales Corp. and for the last 2½ yr. with Commercial Advertising Agency of Chicago has been elected vice-president of the agency. Mr. Brockson is past president of Engineering Advertising Assn., a director of Chicago Federated Advertising Club and frequently a contributor to the pages of business papers.

AT THE first meeting of the Industrial Smoke Abatement Assn. of Hudson Co., N. J., on Sept. 17, at Stevens Institute of Technology, in Hoboken, F. S. Wilson, of the Babcock & Wilcox Co., New York City, will be the principal speaker, his subject being Modern Boilers and Refractories. The association was recently formed by some 300 industries to coöperate with the Department of Smoke Regulation in eliminating smoke from industrial plants, and will hold meetings every 60 days. On Nov. 19, W. G. Christy will speak on Combustion. On Jan. 21, J. G. Berger will speak on Boiler Room Instruments and Improved Furnace Design. On March 18, H. C. Frank will speak on Latest Results of Air Pollution Investigation. On May 20, an inspection trip will be made to the plant of Koppers Gas & Coke Co. at Kearny. All meetings will be at 2 p. m. in the Physics Lecture Room of the Institute. Officers of the association are A. W. Akins, of Standard Oil Co., president; Harry Yunker, of Jersey City Printing Co., secretary; John Gerhard, of Swift & Co., treasurer. The program committee is S. G. Dalrymple, Joseph Dixon Crucible Co., chairman; G. H. Binder, Jersey City; A. C. Curran, Penick & Co.; J. L. Hodges, Deputy Smoke Abatement Engineer; G. N. Proctor, Emark Battery Co.

G. DONALD SPACKMAN, newly-appointed General Superintendent of Lukens Steel Co., Coatesville, Pa., has been president of Lukenweld, Inc., division of Lukens Steel Co. Mr. Spackman was born on June 29, 1895, at Coatesville, and attended the Coatesville High School and Swarthmore College, graduating from the latter in 1917 with the degree of Bachelor of Arts. His Mechanical Engineering degree was awarded in 1924 by Swarthmore. In the summer of 1919, Mr. Spackman joined Lukens Steel Co., serving in the mechanical department and handling

steam, hydraulic and combustion problems. In December of 1920, he was appointed fuel engineer for the Company, serving in that capacity until August 1925 when he was appointed superintendent of the flanging department. In August, 1929, he was appointed assistant general superintendent of Lukens Steel Co. and when the Lukenweld division was formed in May, 1930, for the design and fabrication of welded steel structures for machinery and equipment service, Mr. Spackman was elected president of Lukenweld. He is a member of the Union League of Philadelphia, Racquet Club of Philadelphia, of the American Society of Mechanical Engineers and the American Welding Society. He enjoys golf and hunting, is interested in photography, and operates Hill Farm, a 300-acre dairy farm at Coatesville, with 70 head of pure bred Jersey cows.

TWO PATENTS on refractories have recently been allowed to J. M. Knote, chief technologist of Quigley Co. of New York. One is for a Refractory Material and Method of Making, covering a new chrome-magnesite refractory for brick and monolithic linings as a substitute for basic brick, either chrome or magnesite, also for places where silica and fire clay have been used and in some instances in place of silicon-carbide. The other patent is for a Refractory Composition for lining furnaces, a chrome-dolomite refractory mixture. Both are for improvements on inventions made by Bronn for Quigley Co. in 1930.

H. H. STECK, formerly of the Norton Co., has been appointed grinding wheel sales representative for United States Rubber Products, Inc., in the Pittsburgh district. Mr. Steck has been selling grinding wheels in the Pittsburgh district for the last twenty years and will now specialize in the latest development, Royalite and Vulcanite high speed wheels.

BERNARD W. LYNCH has been elected president of Standard Gas & Elec. Co., succeeding John J. O'Brien, who died August 7. Mr. Lynch has resigned as director and vice-president of H. M. Byllesby & Co. with which he has also been associated for many years. Mr. Lynch who is 52 years old, a native of Ottawa, Ill., and a resident of Chicago, has been identified continuously with the development of the Standard Gas & Electric group of utilities since 1905. His early business experience was with the electrical manufacturing industry and utility operations in Chicago. He joined the Byllesby organization in 1905 as auditor. He was later associated in an official capacity with operating utility companies in various parts of the country. He became general auditor of Standard Gas & Elec. Co. in 1914; in 1923 director and vice-president; in 1928 chairman of the finance committee. Mr. Lynch for many years has almost constantly participated in and supervised the organization, administration, financing and merging of corporations of various kinds, particularly of operating public utility companies and holding companies.

Robert J. Graf of Chicago has been elected president of H. M. Byllesby & Company to succeed the late John J. O'Brien. He has been first vice-president since 1924. Mr. Graf was one of the original partners of the Byllesby company when it was founded in 1902.

Mr. Graf is 54 years old and a native of Washington, D. C. His first executive position with Byllesby & Company was secretary and assistant treasurer.

UNDER THE DIRECTION of Professor W. L. Badger of the University of Michigan, The Dow Chemical Co. announces the formation of the Consulting Engineering Division of the company for the purpose of carrying on a new engineering service available to present and prospective users of Dow products. The address of this division will be 204 Nickels Arcade, Ann Arbor, Mich. It will coöperate with individuals and other consulting organizations and make available to them the broad engineering background of the experience of the parent company.

MCINTOSH & SEYMOUR CORP., of Auburn, New York, which is a wholly owned subsidiary of American Locomotive Co., was merged on September 1, 1936, with the parent company and the business heretofore conducted by the McIntosh & Seymour Corp. will hereafter be carried on by American Locomotive Co., Diesel Engine Division, Auburn, New York.

In the merger the American Locomotive Co. acquired the assets of the McIntosh & Seymour Corp., including the manufacturing plant at Auburn, N. Y., sales orders and contracts, and the

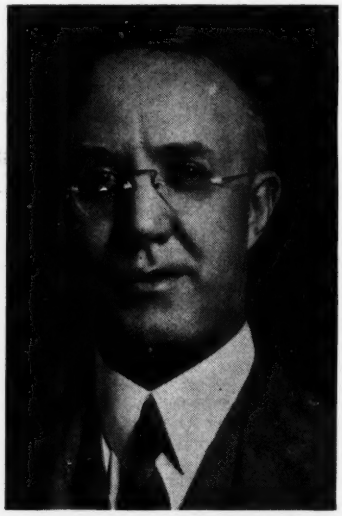


Photo by Blank-Stoller
Robert B. McColl

operating, sales and administrative personnel, and assumed all the liabilities, including contracts and orders for the purchase of materials and supplies. The merger will involve no interruption in the service heretofore rendered to customers by the McIntosh & Seymour Corp.

Robert B. McColl, president of the McIntosh & Seymour Corp., has been appointed vice-president of American Locomotive Co., Diesel Engine Division, and Henry T. Sherman, John Thomas and Heinrich Schneider have been appointed assistant vice-presidents.

For the Engineer's Library

YOUR INVENTION — HOW TO PROTECT AND MERCHANDISE IT. By Elmore B. Lyford. Published by the Radio and Technical Publishing Co., 45 Astor Place, New York City. Size 5½ by 8½ in., 198 pp., cloth bound. Price $1.50.

This is an unusual presentation of the subject of patents by a man who has no patent advice or service to sell or is not interested in patent or trade mark promotion. It covers in very simple language, in a comprehensive way, the matter of patent protection, sale or licensing of patent manufacturing and marketing, relation of employee and employer and gives the uninformed inventor information of a general nature which he should know before proceeding into unfamiliar territory. The book is divided into six parts. The first, How Patents Are Procured, gives a review of the Patent Department, telling how the idea is protected, what can be protected, notes on selecting a patent attorney, etc. Part 2, covers Exploiting the Patent Successfully, selling, licensing and manufacturing, foreign patents, etc. Part 3, trade marks, Part 4, copyrights. Part 5 and 6 are included in the appendix and cover suggested legal forms and extracts from the patent laws of the U.S.A.

PUBLIC OWNERSHIP, by Howell Wright, published by Harold Wright, 440 The Leader Bldg., Cleveland, Ohio. Size 6 by 9 in., paper bound.

This book is a story of the building and operation of the municipal light and power plant at Oberlin, Ohio, which puts forth the promises and results secured from this plant built at public expense. The author points to the promises made by the village manager and the consultant who had charge of the engineering work and building of the plant and through detailed analyses of the cost of construction and operation shows how this plant has been a failure from a business standpoint and indicating that the 1936 business is headed straight for the red ink. It is well worth the time an engineer

would spend in reading this booklet to find out just how projects of this sort are promoted and pushed through to completion.

DIESEL ELECTRIC PLANTS. By Edgar J. Kates. Published by American Technical Society, Chicago, Ill. Size 5½x8½ in. Cloth bound. 176 pp. Price $2.

There are many books dealing with the Diesel engine as a unit but this is the most extensive and complete (perhaps the only) book, dealing with the Diesel electric plant. Inasmuch as Diesel engines are used extensively in driving electric generator equipment, the entire plant and the electrical equipment itself is influenced greatly by the characteristics of the engine. Important characteristics of these machines are reviewed and this is followed by various types of generators used with them. Voltage regulation, voltage regulators, parallel operation, governors and frequency control, automatic plants, electric controls and alarms are covered in considerable detail and several chapters are devoted to the installation and maintenance of electrical equipment.

PRINCIPAL ELECTRIC UTILITY SYSTEMS IN THE UNITED STATES. Federal Power Commission, 90 p. size 9x11½. Illustrated with map illustrations and with two supplementary map inserts. U. S. Government Printing Office, Washington, D. C., 1936. For sale by the Federal Power Commission, Washington, D. C. $1.00 paper; $1.50 buckram.

This report is the second made by the Federal Power Commission under the National Power Survey. The purpose of this report is to supply the demand of both technical and non-technical readers for a simple but comprehensive view of some of the more important physical, financial and operating characteristics of the principal electric utility systems of the United States. It presents for the first time an authoritative map of the areas served by the principal electric utility systems in the United States, together with a complete list of the systems and of the intermediate companies and subsidiaries controlled by them, the state in which they operate and a set of summaries giving general characteristics, financial characteristics, physical and electric operating characteristics, and other information. The data set forth in this report supplement the engineering and economic data presented in the interim report of the National Power Survey, Power Series No. 1. The latter analyzed the power resources and requirements of the United States, the present report seeks to show the characteristics of the corporate groups that in a large measure control those resources and are primarily responsible for supplying the nation's power requirements.

THE CUMMINS ENGINE CO., Columbus, Indiana, has issued a very attractive bulletin, FS-100, on Cummins Diesels, pointing out with photographs, wash drawings and line drawings the distinctive features of these engines which have an enviable record of performance in automotive, industrial, marine and locomotive fields.

THE SMOKE PREVENTION ASSOCIATION has recently published its Manual of Smoke and Boiler Ordinances and Requirements which has been compiled in the interest of smoke and air pollution regulation and fuel combustion. This manual contains such information as a code for regulating steam heating boilers, standard specifications, method of boiler selection, firing of Pocahontas coal by the conical method, a number of technical articles on the abatement of smoke and a great amount of information on the activities of smoke abatement departments in leading cities of the country.

SEAMLESS STEEL EQUIPMENT CORP., New York, N. Y., has recently issued its Catalog K dealing with seamless steel forged, rolled and drawn products for high pressures and high temperatures encountered in power plants and other industries.

THE BRISTOL CO., Waterbury, Conn., has recently published bulletin No. 436 covering a new line of round chart recording voltmeters and ammeters for electric utilities and industrial plants. Illustrations with dimension drawings are given for models for walls, switchboard, flush panel and pole mounting as well as for portable uses.

EDGE MOOR IRON WORKS, Edge Moor, Del., is distributing an attractive bulletin descriptive of some of the fabricated process equipment in various metals which the company uses in fabrication of steel, stainless steels, aluminum, stainless-clad, monel metal, nickel, everdur, ni-clad. This bulletin is designated as No. 101.

ANALYSIS OF FLOW in Networks of Conduits or Conductors is the title of University of Illinois Bulletin No. 286 recently issued by the University of Illinois Engineering Experiment Station.

STANDARD MARKING OF VALVES AND FITTINGS is covered in a new edition of Standard Practice covering MSS Standard Marking System for Valves, Fittings, Flanges and Unions, SP-25-1936, just issued by the Manufacturers Standardization Society of the Valve and Fittings Industry. The method of applying the general rules for marking as set forth in SP-25 is more specifically visualized in this new edition, by the inclusion of a number of tables definitely outlining the standard method of applying uniform markings to a wide variety of products. SP-25 is one of a series of Standard Practices developed and published by the Society. Copies may be secured for 50 cents each from the Society, 420 Lexington Ave., New York, N. Y.

THREE NEW BULLETINS dealing with indicating pyrometers and the use of pyrometers for temperature control have just been issued by Wheelco Instruments Co., 1112 Milwaukee Ave., Chicago, Ill. These bulletins cover indicating pyrometers, models 20, 30, 40 and 50; The Limitro, an automatic shut off for protecting furnaces from excessive heating; and the Flame-Otrol, an automatic gas shut off actuated when the flame is extinguished.

IN AN attractive and informative 16-p. booklet, Air Conditioning Instruments and Controls are illustrated and described and their uses and advantages for regulating temperature and humidity to give desired comfort or process conditions are discussed. Many examples of installations using the Friez control and instruments are also shown. The booklet may be had on request to Julien P. Friez & Sons, Inc., Baltimore St. and Central Ave., Baltimore, Md.

MAKE MINE EGG is the title of a unique bulletin published by Appalachian Coals, Inc., Cincinnati, Ohio, for distribution by its affiliated companies and authorized agents. This folder suggests that "egg coal offers the greatest overall value of any of the coal sizes" and lists 17 reasons why householders should give consideration to using this size. The factual information was prepared by the ACI fuel engineering division as an authority on coals and coal-burning equipment.

PROPERTIES and Applications of Heat-treated Wrought Nickel Alloy Steels are discussed with charts of the mechanical properties of various alloys in Bulletin P-1 issued by The International Nickel Co., Inc., of New York City. Use of water or oil for hardening is treated, and illustrations given of the proper alloy to use for various purposes such as crank shafts, elastic bellows, chain, gears and roller bearings.

FLYNN AND EMRICH CO., Baltimore, Md., has recently issued two bulletins dealing with its underfeed stokers. One of these illustrates and describes the industrial type Series 60 and the commercial type Series 50. The other bulletin is devoted to information on heavy duty Series 70. These bulletins go into some detail in regard to construction of the stokers and illustrate their application to a number of modern boilers now being installed.

SCREW PUMPS is the subject of bulletin 162 which has just been published by Morris Machine Works, Baldwinsville, New York. The bulletin outlines the development of this interesting type of centrifugal pump, explains its applications, and describes the special features of the Morris design, which is especially suited for handling sewage, drainage water, and water for irrigation service, and condenser circulation.

TWO NEW BULLETINS, one, No. 180 on Distribution Transformers and the other, No. 181 on Power Transformers have recently been issued by the Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo. These are attractively illustrated and contain complete design data and descriptions of Wagner Transformers.

ALLIS-CHALMERS MFG. CO., Milwaukee, Wisconsin will on request send its new leaflet 2172A on Outage-Free High Voltage Distribution Transformers, Type CB. It describes and illustrates an improved distribution transformer especially designed to serve the Public Utilities in extending the benefits of electrical service to rural communities. Among the requirements said to be fulfilled by this type of transformer are maximum reliability against transient voltages such as lightning, convenience in changing tops, adaptability for simplified pole construction, freedom from oil siphoning, high all-day efficiency.

LINK-BELT CO., Chicago, Ill., has issued a new 24 p. illusrated catalog No. 1562 devoted to vibrating screen equipment suitable for use with coal, clay, coke, sand, gravel, crushed stone and similar materials. The catalog is clearly illustrated with diagrams and dimension tables of the manufactured equipment.

THE SWARTWOUT CO., Cleveland, Ohio, has recently published a non-technical bulletin designated as Bulletin V-100-B which deals with the problem of ventilation in industrial and commercial buildings particularly the application of Rotary Ventilators and the Swartwout Dexter Heat Valve.

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis. has just released a new 36 page steam turbine bulletin number 1179 covering in detail all of that company's condensing automatic extraction turbine frames for the capacity range of 500 kw. through 5000 kw. and turbo-alternator construction. Of special interest is the new high steam temperature turbine frame covering a capacity range of 2500 kw. through 5000 kw., in which the oil piping and steam piping are located on opposite sides of the turbine to guard against oil fires.

Power Plant Construction News

Calif., Los Angeles — Pittsburgh Plate Glass Co., Maie Ave., plans installation of electric power equipment in new three-story addition to local paint and enamel-manufacturing plant. Entire project will cost over $80,000. Albert C. Martin, Higgins Building, is architect. Company headquarters are in Grant Building, Pittsburgh, Pa.

Calif., Oakland—United Autographic Register Co., 19th and Union Sts., plans installation of electric power equipment in new one and two-story manufacturing plant at Beach and 34th Sts. Entire project will cost about $150,000. Pereira & Pereira, 333 N. Michigan Ave., Chicago, Ill., are architects. Carter Norris is general manager.

Ga., Rome—Tubize Chatillon Corporation, 2 Park Ave., New York, N. Y., has plans maturing for extensions in power plant at rayon mill at Rome, in connection with enlargement of mill, recently referred to in these columns, to include installation of a 2500 or 3000-kw. turbo-generator unit with accessories, high-pressure boiler, feedwater heater, pumps and auxiliary equipment; company will also install new brine-pumping machinery and ammonia-condensing equipment for mill service. Entire project, including mill additions, will cost close to $2,000,000. Robert & Co., Bona-Allen Building, Atlanta, Ga., are engineers.

Ind., Jeffersonville — Colgate-Palmolive-Peet Co., 105 Hudson St., Jersey City, N. J., plans installation of electric power equipment in new 5-story addition to branch soap-manufacturing plant at Jeffersonville. Cost close to $200,000. Company will also make similar installation in large addition to branch plant at 58-64 Natalie St., Toronto, Ont., to cost approximately a like sum.

Kan., Iola—City Council is completing plans for extensions and improvements in municipal electric power plant, to include installation of turbo-generator unit and auxiliary equipment. Cost about $225,000. Financing will be arranged through Federal aid. Paulette & Wilson, Farmers' Union Building, Salina, Kan., are consulting engineers.

Ky., Glasgow—Common Council has preliminary plans under way for new municipal electric power plant, estimated to cost close to $200,000, with equipment. Proposed to hold election to vote bonds in that sum at early date.

Ky., Lexington—Lexington Brewing Co., care of John C. Bruckmann, head of Bruckmann Brewing Co., Ludlow Street and Central Parkway, Cincinnati, Ohio, recently organized with capital of $400,000 by Mr. Bruckmann and associates, plans installation of power equipment in proposed new local brewing plant. A power house will be built. Entire project is reported to cost close to $150,000.

Ky., Middleboro—Common Council has authorized a vote of citizens at forthcoming general election, November 3, on bond issue of $175,000, proceeds to be used for construction of a municipal electric power plant. J. S. Watkins, Lexington, Ky., is consulting engineer.

La., Baton Rouge—Ethyl Gasoline Corporation, 135 East 42nd St., New York, N. Y., plans installation of power equipment in new multi-unit plant at Baton Rouge, for production of Ethyl fluid for gasoline manufacture. Tract of 190 acres of land has been secured for plant. Contract has been made with Louisiana Steam Generating Corporation, Baton Rouge, for power supply. Entire project is reported to cost close to $2,000,000. E. I. du Pont deNemours & Co., Wilmington, Del., is interested in enterprise.

Mich., Detroit—Arvey Corporation, 6400 East Nevada Street, plans installation of electric power equipment in two new additions, 150x200 ft., and 40x77 ft., to automobile parts manufacturing plant. Entire project will cost over $100,000. I. M. Lewis, Inc., Cadillac Square Building, is architect.

Mich, Detroit—Kelvinator Corporation, 14250 Plymouth St., manufacturer of electric refrigerator units, oil burners, etc., plans installation of electric power equipment in proposed new addition to plant. Cost over $100,000. Work is scheduled to begin this fall.

Miss., Columbus—City Council has plans maturing for new municipal electric power plant and distributing lines. Cost about $275,000. Financing is being arranged through Federal aid. A. H. Beard Engineering Co., 44 South Central St., St. Louis, Mo., is consulting engineer.

Mont., Hardin—Holly Sugar Corporation, Colorado Springs, Colo., plans construction of a power house at proposed new beet sugar mill at Hardin, where large site has been acquired. Electric power equipment will be installed for mill service. Entire project will cost close to $700,000.

Nev., Winnemucca—Common Council has plans maturing for new municipal electric power plant. Cost estimated at $120,000. Financing is being arranged through Federal grant and loan. Proposed to proceed with project early in the fall.

N. Y., Buffalo—Henry & Henry, Inc., 304 Michigan Ave., manufacturer of bakers' equipment and supplies, plans new one-story steam power house in connection with new one-story plant addition, Nortland Avenue. Entire project will cost close to $60,000. H. E. Plumer & Associates, 775 Main St., are architects and engineers.

Ohio, Bedford — Republic Bronze Powder Co., an interest of Sheffield Bronze Powder Co., 3000 Woodhill Road, Cleveland, Ohio, plans boiler plant in connection with new bronze powder works on Forbes Road, Bedford Township. Entire project will cost about $50,000. Edward Hoefler, 5005 Euclid Ave., Cleveland, is engineer.

Ohio, Coldwater—Pet Milk Co, Arcade Building, St. Louis, Mo., plans installation of electric power equipment in new milk condensing plant at Coldwater, where tract of land was recently selected. Entire project will cost over $225,000. Proposed to begin work in fall. Helfensteller, Hirsch & Watson, Chemical Building, St. Louis, are architects.

Ohio, Middletown—Sorg Paper Company, Manchester Ave., plans installation of electric power equipment in new two-story plant unit at 1730 Grand Ave., adjoining mill of Lawrence Bag Company. An addition will be built to power plant of last noted company, with installation of new equipment for increased capacity. Entire project will cost over $175,000. C. E. Aull is assistant secretary, in charge.

Ohio, Youngstown—Swift & Co., West Commerce St., meat packers, plan installation of electric power equipment in proposed new local packing plant, for which site is being selected. A boiler house is planned. Entire project is reported to cost about $140,000. Headquarters are at Union Stock Yards, Chicago, Ill.

Pa., Pittsburgh—Department of Public Works, City-County Building, L. M. Johnston, director, plans installation of equipment in power house at municipal Market Building, including boiler unit equipped to use pulverized coal, automatic stoker, coal and ash-handling machinery and auxiliary equipment.

Pa., Pittsburgh — Pittsburgh Steel Co., Union Trust Building, plans installation of electric power equipment in connection with expansion and improvements in plant. Company has arranged financing through sale of stock to total over $1,000,000, considerable portion of fund to be used for purpose noted.

Pa., Warren—Penn-York Oil Co., Inc., Olean, N. Y., plans construction of new power house, with gas-air pressure plant for oil-drilling and operating service at oil properties in Southwest Township, Warren County, near Warren, where an extensive development program has been authorized. Entire project is reported to cost over $100,000.

Texas, Houston—Dixon Packing Co., 108 Milam St., plans installation of electric power equipment in new food products manufacturing plant on Calhoun Road, where 3-acre tract of land has been acquired. Entire project will cost about $80,000. Joseph Finger, Inc., National Standard Building, Houston, is architect.

Utah, Garfield—American Smelting & Refining Co., 120 Broadway, New York, N. Y., plans installation of power equipment for expansion and improvements in smelting plant at Garfield, including installation of new reverberatory furnace and other production facilities. Power house will be enlarged and additional equipment installed. Entire project will cost close to $500,000.

Va., Harrisonburg—Shenandoah Valley Electric Co-operative, Inc., recently organized, plans construction of a steam-electric generating plant for power service for rural electrical distributing system in parts of Shenandoah, Augusta and Rockingham Counties. Financing is being arranged through Federal aid. Fund of $125,000 has been secured for line construction, totaling about 100 miles.

Va., Jewell Ridge—Jewell Ridge Coal Co., plans installation of power equipment in connection with proposed rebuilding of portion of coal-mining plant, recently destroyed by fire with loss estimated close to $100,000. Headquarters of company are at Tazewell, Va.

Wis., Antigo—Antigo Milk Products Co-operative Co., has plans under way for new addition to steam power house at local plant, including installation of boiler unit and auxiliary equipment. G. A. Krasin, Marshfield, Wis., is architect.